60 MHz Dual Time Base Oscilloscope

PM3055

Service Manual

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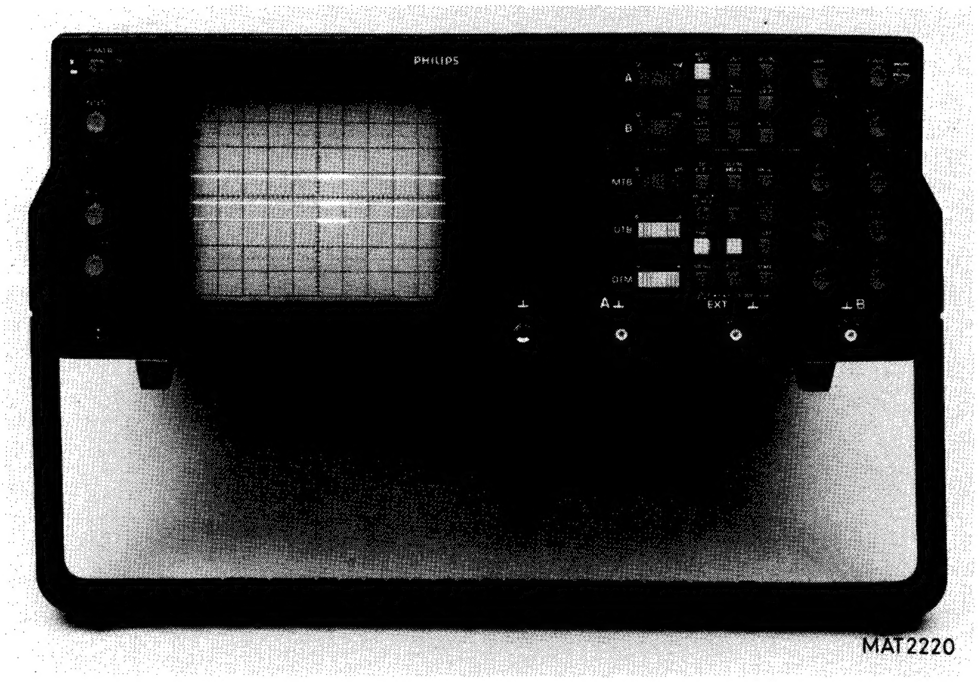
880411/2



WARNING: These servicing instructions are for use by qualified personnel only. To reduce the risk of electric shock do not perform any servicing other then that specified in the Operating Instructions unless you are fully qualified to do so.

PHILIPS

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IMPORTANT: In correspondence concerning this instrument, please quote the type number and serial number as given on the type plate.

NOTE: The design of this instrument is subject to continuous development and improvement. Consequently, this instrument may incorporate minor changes in detail from the information contained in this manual.

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CONTENTS Page

LIST OF FIGURES

1. SAFETY INSTRUCTIONS

Read these pages carefully before installation and use of the instrument.

1.1 INTRODUCTION

The following clauses contain information, cautions and warnings which must be followed to ensure safe operation and to retain the instrument in a safe condition.
Adjustment, maintenance and repair of the instrument shall be carried out only by qualified personnel.

1.2 SAFETY PRECAUTIONS

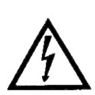
For the correct and safe use of this instrument it is essential that both operating and servicing personnel follow generally-accepted safety procedures in addition to the safety precautions specified in this manual.
Specific warning and caution statements, where they apply, will be found throughout the manual.
Where necessary, the warning and caution statements and/or symbols are marked on the apparatus.

1.3 CAUTION AND WARNING STATEMENTS

CAUTION: is used to indicate correct operating or maintentance procedures in order to prevent damage to or destruction of the equipment or other property.

WARNING: calls attention to a potential danger that requires correct procedures or pracites in order to prevent personal injury.

1.4 SYMBOLS

	High voltage $\geq$ 1000 V	(red)
	Live part	(black/yellow)
	Read the operating instructions	
	Protective earth (grounding) terminal	(black)

1.5 IMPAIRED SAFETY-PROTECTION

Whenever it is likely that safety-protection has been impaired, the instrument must be made inoperative and be secured against any unintended operation. The matter should then be referred to qualified technicians.
Safety protection is likely to be impaired if, for example, the instrument fails to perform the intended measurements or shows visible damage.

1.6 GENERAL CLAUSES

1.6.1 WARNING: The opening of covers or removal of parts, except those to which access can be gained by hand, is likely to expose live parts and accessible terminals which can be dangerous to live.

1.6.2 The instrument shall be disconnected from all voltage sources before it is opened.

1.6.3 Bear in mind that capacitors inside the instrument can hold their charge even if the instrument has been separated from all voltage sources.

1.6.4 WARNING: Any interruption of the protective earth conductor inside or outside the instrument, or disconnection of the protective earth terminal, is likely to make the instrument dangerous. Intentional interruption is prohibited.

1.6.5 Components which are important for the safety of the instrument may only be renewed by components obtained through your local Philips organisation. (See also section 15).

1.6.6 After repair and maintenance in the primary circuit, safety inspection and tests, as mentioned in section 15 have to be performed.

2. CHARACTERISTICS

A. Performance Characteristics

- Properties expressed in numerical values with stated tolerance are guaranteed by PHILIPS Specified non-tolerance numerical values indicate those that could be nominally expected from the mean of a range of identical instruments.
- This specification is valid after the instrument has warmed up for 30 minutes (reference temperature 23°C).
- For definitions of terms, reference is made to IEC Publication 351-1.

B. Safety Characteristics

- This apparatus has been designed and tested in accordance with Safety Class I requirements of IEC Publication 348, Safety requirements for Electronic Measuring Apparatus, UL 1244 and CSA 556B and has been supplied in a safe condition.

C. Initial Characteristics

. Overall dimensions:

- Width

Including handle	: 387 mm
Excluding handle	: 350 mm

- Length

Including handle, excl. knobs	: 518,5 mm
Excluding handle, excl. knobs	: 443,5 mm
Including handle, incl. knobs	: 530,5 mm
Excluding handle, incl. knobs	: 455,5 mm

- Height

Including feet	: 146,5 mm
Excluding feet	: 134,5 mm
Excl. under cabinet	: 132,5 mm

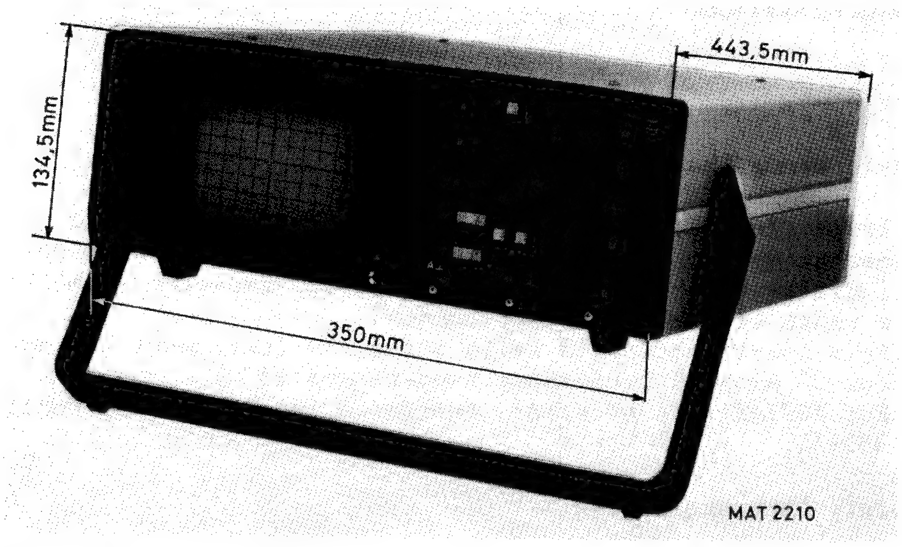


Figure 2.1 Dimensions

* Mass : 7,5 kg

* Operating positions:

  a. Horizontally on bottom feet
  b. Vertically on rear feet
  c. On the carrying handle in two sloping positions.

D. CONTENTS

2.1. Display
2.2. Vertical deflection or Y axis
2.3. Horizontal deflection or X axis
2.4. Triggering
2.5. Power Supply
2.6. Auxiliary inputs or outputs
2.7. Environmental characteristics
2.8. Safety

	CHARACTERISTICS	SPECIFICATION	ADDITIONAL INFORMATION
2.1	DISPLAY		
	* CRT		
	Type No	PHILIPS D 14-372	
	Measuring area (h x w)	80 x 100 mm	8 x 10 div. 1 div. = 10 mm 1 subdiv. (sd) = 2 mm
	* Screen type		
	Standard	GH (P 31)	
	Option	GM (P 7)	Long persistence
	* Total acceleration voltage	16 kV	
	* Graticule		
	Engravings	Internal fixed	
	Division lines	1 cm	Horizontal as well as vertical
	Subdivisions	2 mm	Idem.
	Dotted lines	1,5 and 6,5 cm from top	Only horizontal.
	Percentages	0%, 10%, 90%, 100%	
	* Orthogonality	90^{o} +/- 1^{o}	Measured in zero point.
	* Illumination	Continuously variable	
	* Display time per channel in chopped mode	< 2 us	
	* LCD liquid crystal display		All relevant settings are visible in display.
	Type No	LC 9438130	
	Visible area	25,4 x 88,8 mm	
	Back lighting	Permanently on	
2.2	VERTICAL DEFLECTION OR Y AXIS		
2.2.1	Channels A and B		
	* Deflection coeff.	2 mV/div...10 V/div	In 1, 2, 5 sequence. If PM 8936/09 is used, deflection coeff. is automatically calculated in display.
	* Variable gain control range	1 : >2,5	
	* Error limit	< +/- 3%	Only in calibrated position.
	* Input impedance	1 M ohm +/-2%	Measured at f_o < 1 MHz
	Paralleled by	20 pF +/-2pF	Measured at f_o < 1 MHz

CHARACTERISTICS	SPECIFICATION	ADDITIONAL INFORMATION
* Max. input voltage	400 V (d.c. + a.c. peak)	
Max. test voltages (rms)	500 V	Max. duration 60 sec.
* Bandwidth for 20 mV...10 V	> 60 MHz (amb.: 0...35°C)	Input 6 div. sine-wave.
Bandwidth for 2 mV, 5 mV and 10 mV	> 35 MHz	Input 6 div. sine-wave.
* Rise-time	5,8 ns or less	Calculated from 0,35/f-3 dB
* Noise 20 mV...10 V	< 0,5 sd	Measured visually. Pick up on open BNC excluded.
* Lower - 3 dB point	< 10 Hz	In AC position, 6 div. sine-wave
* Dynamic range		
@ 1 MHz	> +/- 12 div.	Vernier in cal. position.
@ 50 MHz	> 8 div.	Vernier in cal. position.
* Position range	> +/- 8 div.	Vernier in cal. position.
* Decoupling factor between channels		Both channels same attenuator setting. Input max. 8 div. sine-wave.
@ 10 MHz	1 : > 100	2,5 and 10 V are excluded.
@ 50 MHz	1 : > 50	2,5 and 10 V are excluded.
* Common Mode Rejection Ratio @ 1 MHz	1 : > 100	Both channels same attenuator setting, vernier adjusted for best CMRR; measured with max. 8 div. (+/- 4 div.) each channel.
* L.F.Non Linearity	< 3%	
* Visible signal delay	> 15 ns	Max. intensity, measured from line start to trigger point

CHARACTERISTICS	SPECIFICATION	ADDITIONAL INFORMATION
* Base-line jump between attenuator steps 20 mV...10 V	< 1 sd	
Additional jump between 10 mV <---> 20 mV	< 1,5 sd	
Normal Invert jump	< 1 sd	Only channel B.
ADD jump	< 0,6 div.	When A and B are positioned in screen centre (20 mV...10 V).
Variable jump	< 1 sd	Max.jump in any position of the vernier.

2.2.2 Triggerview

* Bandwidth via A or B channel 2 mV, 5 mV, 10 mV	> 35 MHz	6 div. sine-wave
20 mV...10 V	> 50 MHz (Amb.: 0...35°C)	
Via EXT. input	> 50 MHz	6 div. sine-wave (+/- 3 div. from screen centre).
* Deflection coeff. Via channel A or B	2 mV/div...10 V/div	1, 2, 5 sequence (see Channel A, B).
Via EXT. input	100 mV/div.	
Error limit	< 5%	INTERNAL, EXTERNAL.
* Lower - 3 dB point AC coupling EXT. input	< 10 Hz	Only when trigger coupling is DC.
* Line jump trigger source	< 2 sd	Jump between trigger source A, B composite and EXT.
* OFFSET trig.point from screen centre	< 1,5 sd	
* Delay EXT. trigger view and channel A or B	< 10 ns	
* Dynamic range EXT. input		
@ 1 MHz	> +/- 12 div.	
@ 50 MHz	> 6 div.	

CHARACTERISTICS	SPECIFICATION	ADDITIONAL INFORMATION
2.3 HORIZONTAL DEFLECTION OR X AXIS		
* Horizontal display modes	MTB, MTBI, ALT.TB, DTB X-DEFL	
2.3.1 Main Time Base (MTB)		
* Time coeff.	0,5 sec...50 ns	1, 2, 5 sequence (magn.off)
Error limit	< 3%	Measured at -4...+4 div. from screen centre.
* Horizontal position range	Start of sweep and 10th div. must be shifted over screen centre	
* Variable control ratio	1 : > 2,5	
* Time Base magnifier	Expansion *10	Not valid in X-deflection.
Error limit	< 4%	Measured at +4...-4 div. from screen centre. Excluding first 50 ns and last 50 ns.
* Horizontal magnifier balance * 10 ---> * 1	< 2,5 sd	Shift start of sweep in * 10 in mid-screen position, then switch to * 1.
* Hold-Off Minimum to maximum hold-off time ratio	1 : > 10	Minimum hold off time is related to time base setting.
2.3.2 Delay Time Base (DTB)		
* Time coeff.	1 ms...50 ns	Sequence 1, 2, 5.
Error limit		See MTB
* Horizontal position range		See MTB
* Time Base Magnifier		See MTB

CHARACTERISTICS	SPECIFICATION	ADDITIONAL INFORMATION
* Delay time Multiplier Error limit	3% + 1% incremental delay error + 25 ns +/- 5 ns	* 1 only
Incremental delay time error	< 1%	* 1 only
* Resolution	1 : 10 000	
* Delay Time Jitter	1 : > 20 000	
* Trace separation		Only valid in alternate time base.
Shift range	> +/- 4 div.	DTB shifts only.

2.3.3 X-deflection

* Deflection coeff. Via channel A or B	2 mV/div...10 V/div	1, 2, 5 sequence.
Via EXT. input	100 mV/div.	
* Error limit Via channel A or B	< +/- 5%	
Via EXT. input	< +/- 5%	
* Bandwidth	DC .... > 2 MHz	DC coupled
* Phase shift between X and Y-deflection	< 3^{o} @ 100 kHz	
* Dynamic range	> +/- 12 div. @ 100 kHz	

2.3.4 EXT input

* Input impedance	1 M ohm +/- 2%	f_o < 1 MHz
Paralleled by	20 pF +/- 2 pF	f_o < 1 MHz
* Max. input voltage	400 V (d.c. + a.c. peak)	
Max. test voltage (rms)	500 V	Max. duration 60 sec.
* Lower - 3 dB point	< 10 Hz	AC coupled

	CHARACTERISTICS	SPECIFICATION	ADDITIONAL INFORMATION
2.4	TRIGGERING		
2.4.1	MTB triggering		
	* Trig.mode		
	AUTO (auto free run)	Bright line in absence of trigger signal	Auto free run starts 100 ms (typ.) after no trig.pulse.
	Triggered		Switches automatically to auto free run if one of the display channels is grounded.
	Single		In multi-channel mode (alternated) each channel is armed after reset; if sweep has already started, sweep is not finished. Not applicable in peak to peak coupling.
	* Trigger source A, B, Composite (AB), EXT, Line		Line trigger source always triggers on main frequency. Line trigger amplitude depends on line input voltage. Approx. 6 div. @ 220 VAC input voltage.
	* Trigger coupling Peak-to-peak (p-p), DC, TVL, TVF		
	* Level range		
	Peak-to-peak	Related to peak-to-peak	p-p coupling is DC rejected.
	DC INTERNAL	> (+ or - 8 div.)	
	DC EXTERNAL	> (+ or - 800 mV)	
	TVL/TVF	Fixed level	
	* Trigger slope	+/-	Slope sign in LCD and + or - if TVL/F in chosen for positive or negative video.
	* Trigger sensitivity		
	INTERNAL		
	0 - 10 MHz	< 0,5 div.	Trig. coupling DC.
	@ 50 MHz	< 1,0 div.	Trig. coupling DC.
	@ 100 MHz	3,0 div.	Trig. coupling DC.
	EXTERNAL		
	0 - 10 MHz	< 50 mV	Trig. coupling DC.
	@ 50 MHz	< 150 mV	Trig. coupling DC.
	@ 100 MHz	500 mV	Trig. coupling DC.
	TVL/F INTERNAL	< 0,7 div.	Sync. pulse.
	EXTERNAL	< 70 mV	Sync. pulse.

	CHARACTERISTICS	SPECIFICATION	ADDITIONAL INFORMATION
2.4.2	DTB Triggering		
	* DTB trigger source Starts, A, B, Composite (AB), EXT and TVL		TVL has same trig.source as MTB trig. source TVL only valid if MTB trig. coupling TVL or TVF is chosen.
	* Coupling	DC	
	* Trigger sensitivity	See MTB	
	* Trigger Level range	> (+ or - 8 div.)	
	* Trigger slope	+/-	Slope sign in LCD, if TVL is chosen. Slope sign is not valid
2.5	POWER SUPPLY		
	* Line input voltage AC		One range.
	Nominal	100 - 240 V	
	Limits of operation	90 - 264 V	
	* Line frequency		
	Nominal	50 - 400 Hz	
	Limits of operation	45 - 440 Hz	
	* Safety requirements within specification of: IEC 348 CLASS I, UL 1244, VDE 0411, CSA 556 B		
	* Power consumption	45 W	

	CHARACTERISTICS	SPECIFICATION	ADDITIONAL INFORMATION
2.6	AUXILIARY INPUTS OR OUTPUTS		
	* Z-MOD		TTL-compatible.
	ViH	> 2,0 V	Blanks display.
	ViL	< 0,8 V	Max. intensity Analogue control between ViH and ViL is possible.
	* DIN plug 9-pin (female)		For IEEE control, front-panel memory back-up.
	* CAL		To calibrate drop or tilt probes.
	Output voltage	1,2 V +/- 1%	Rectangular output pulse.
	Frequency	2 kHz	
	The output may be short-circuit to ground.		

2.7 ENVIRONMENTAL CHARACTERISTICS

The environmental data mentioned in this manual are based on the results of the manufacturer's checking procedures.
Details on these procedures and failure criteria are supplied on request by the PHILIPS organisation in your country, or by PHILIPS, INDUSTRIAL AND ELECTRO-ACOUSTIC SYSTEMS DIVISION, EINDHOVEN, THE NETHERLANDS.

* Meets environmental requirements of:	MIL-T-28800 C, type III, CLASS 5 Style D	
* Temperature		
Operation temp. range within specification	10...40°C	MIL-T-28800 C par. 3.9.2.3. tested, par. 4.5.5.1.1.
Limits of operation temperature range	0 ...50°C	Idem.
Non-operating (Storage)	- 40°C/+ 75°C	MIL-T-28800 C par. 3.9.2.3. tested, par. 4.5.5.1.1.
* Max. humidity operating non-operating	95% RH	10...30°C
* Max. altitude		MIL-T-28800 C par. 3.9.3. tested, par. 4.5.5.2.
Operating	4,5 km (15000 feet)	Maximum (Operating Temperature derated 3°C for each km, for each 3000 feet, above sea level).
Non-operating (storage)	12 km (40 000 feet)	

CHARACTERISTICS	SPECIFICATION	ADDITIONAL INFORMATION
* Vibration (operating)		MIL-T-28800 C par. 3.9.4.1. tested, par. 4.5.5.3.1.
Freq. 5...15 Hz Sweep Time	7 min.	
Excursion (p-p)	1,5 mm	
Max Acceleration	7 m/s^2 (0,7 x g)	@ 15 Hz
Freq. 15...25 Hz Sweep Time	3 min.	
Excursion (p-p)	1 mm	
Max Acceleration	13 m/s^2 (1,3 x g)	@ 25 Hz
Freq. 25...55 Hz Sweep Time	5 min.	
Excursion (p-p)	0,5 mm	
Max Acceleration	30 m/s^2 (3 x g)	@ 55 Hz
Resonance Dwell	10 min.	@ each resonance freq. (or @ 33 Hz if no resonance was found). Excursion, 9.7.1. to 9.7.2.
* Shock (operating)		MIL-T-28800 C par. 3.9.5.1. tested, par. 4.5.5.4.1.
Amount of shocks total	18	
each axis	6	(3 in each direction).
Shock Wave-form	Half sine-wave	
Duration	11 ms	11 ms
Peak Acceleration	300 m/s^2 (30 x g)	
* Bench handling		Mil-T-28800 C par. 3.9.5.3. tested, par. 4.5.5.4.3.
Meets requirements of	MIL-STD-810 method 516, proced. V	
* Salt Atmosphere		MIL-T-28800C par. 3.9.8.1 tested, par. 4.5.6.2.1.
Structural parts meet requirements of	MILT-STD-810 methode 509, proced. I salt solution 20%	
* EMI (Electronic Magnetic Interference) meets requirements of	MIL-STD-461 CLASS B	Applicable requirements of part 7 : CE03, CS01, CS02, CS06, RE02, RS03
	VDE 0871 and VDE 0875 Grenzwertklasse B	

CHARACTERISTICS	SPECIFICATION	ADDITIONAL INFORMATION
* Magnetic Radiated Susceptibility Maximum Deflection Factor		Tested in conformity with IEC 351-1 par. 5.1.3.1. Measured with instrument in a homogeneous magnetic field (in any direction with respect to instrument) with a flux intensity (p-p value) of 1,42 mT (14,2 gauss) and of symmetrical sine-wave form with a frequency of 45...66Hz.

2.8 SAFETY

CHARACTERISTICS	SPECIFICATION	ADDITIONAL INFORMATION
* Meets requirements of	IEC 348 CLASS I	
	VDE 0411	Except for power cord, unless shipped with Universal European power plug.
	UL 1244 CSA 556 B	Except for power cord, unless shipped with North American power plug.
* Max. X-Radiation		Measured @ 5 cm from surface of instrument for a target area of 10 cm^2
* Recovery time	15 min.	$-10^{o}C$ ----> + $25^{o}C$ ambient temp.
	30 min.	$-20^{o}C$ ----> + $25^{o}C$ ambient temp.
	45 min.	$-30^{o}C$ ----> + $25^{o}C$ ambient temp.
	60 min.	$-40^{o}C$ ----> + $40^{o}C$ ambient temp.

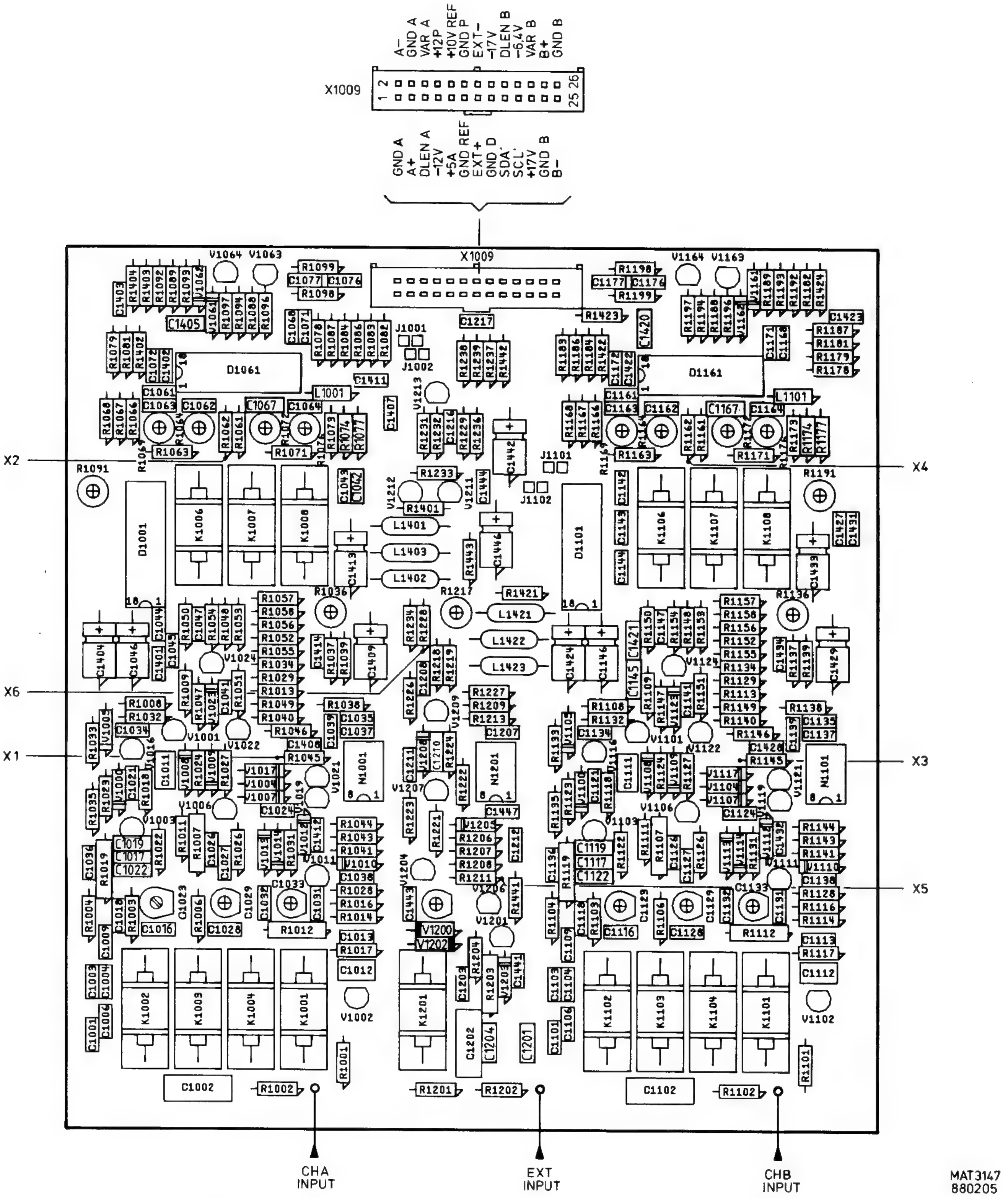


Figure 4.2 Attenuator unit p.c.b.

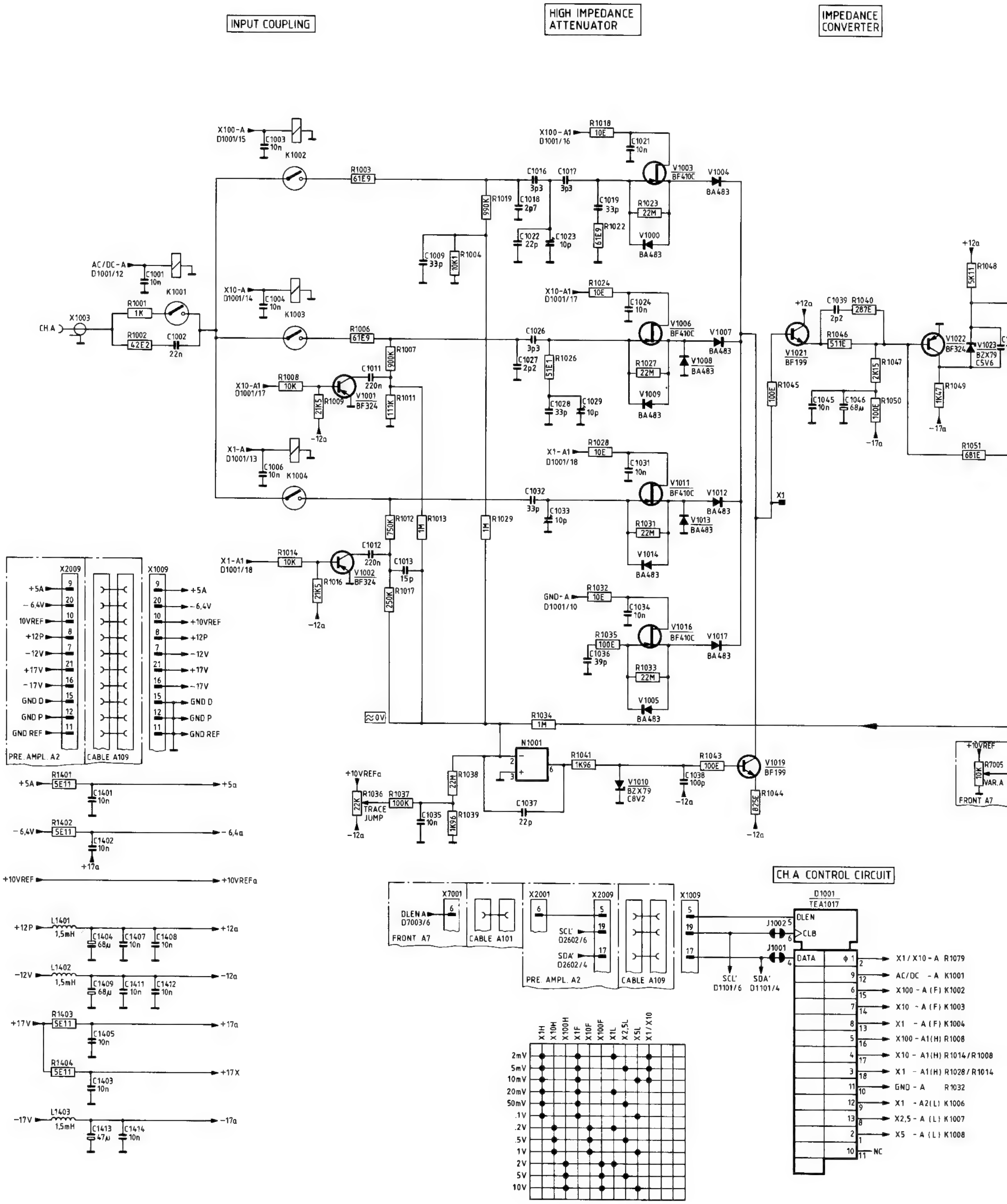
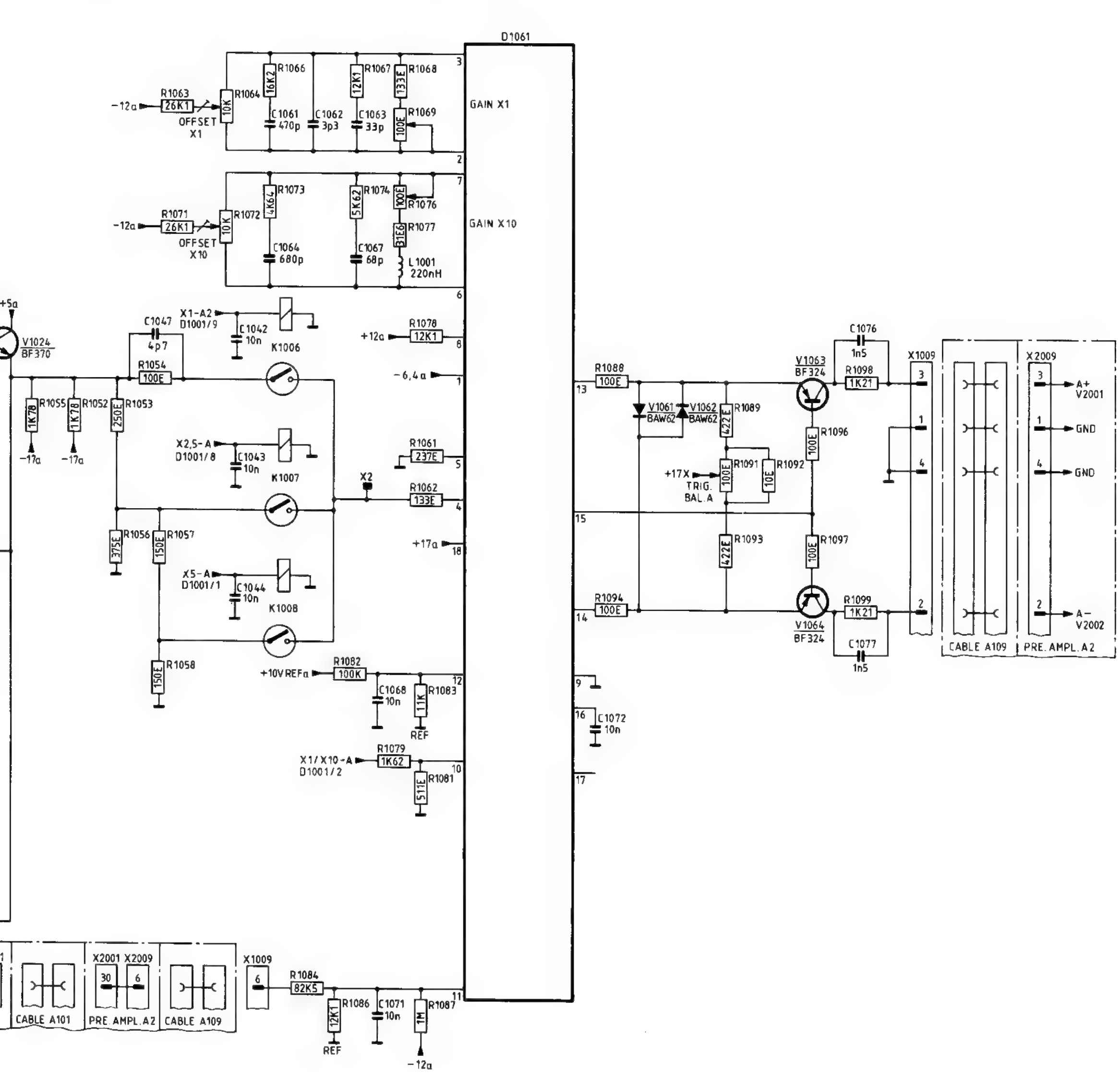


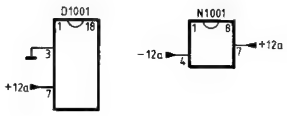
Figure 4.3 Circuit diagram of attenuator, ch. A

LOW IMPEDANCE ATTENUATOR

GAIN SWITCH VAR CIRCUIT



REF NO.	TYPE
D1001	TEA1017
D1061	OQ0203
N1001	μA714



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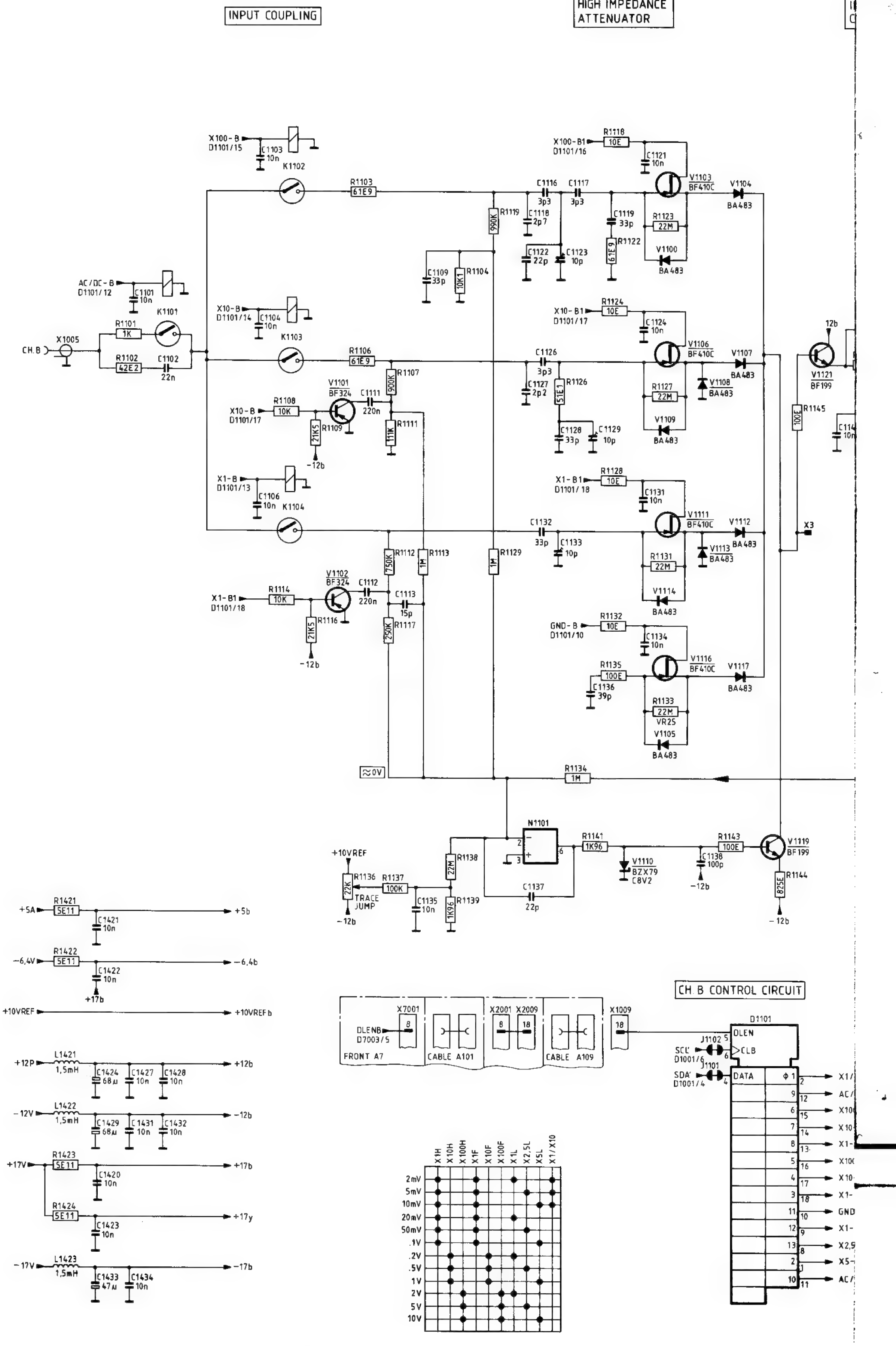
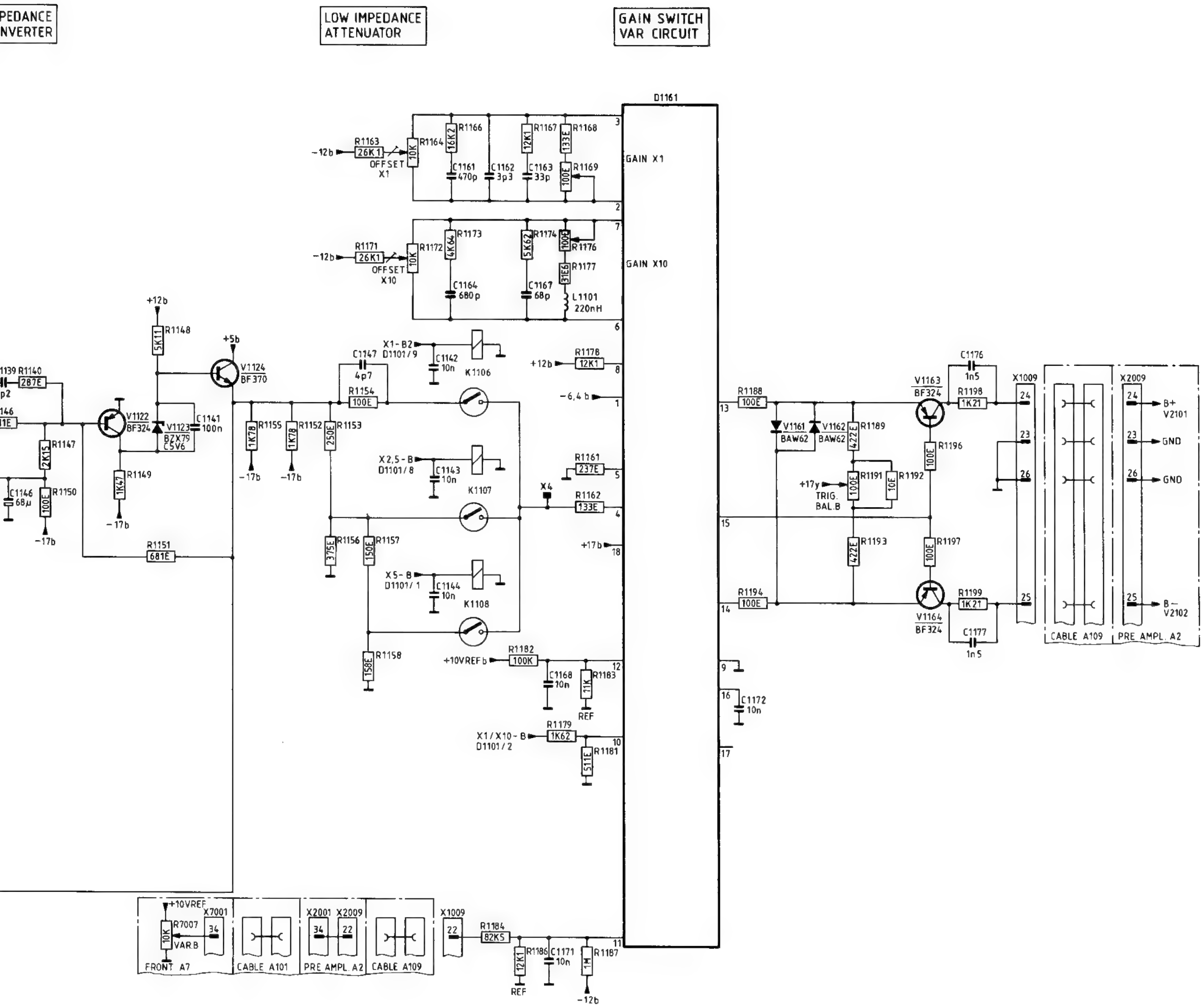


Figure 4.4 Circuit diagram of attenuator, ch. B



REF NO	TYPE
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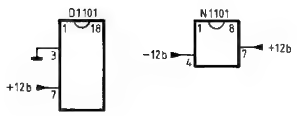
D1161	OQ0203
N1101	µA714



0-B R1179
-B K1101
B K1102
K1103
K1104
1 R1118
1 R1108 / R1124
R1114 / R1128
B R1132
K1106
B K1107
K1108
EXT K1201

MAT 3170
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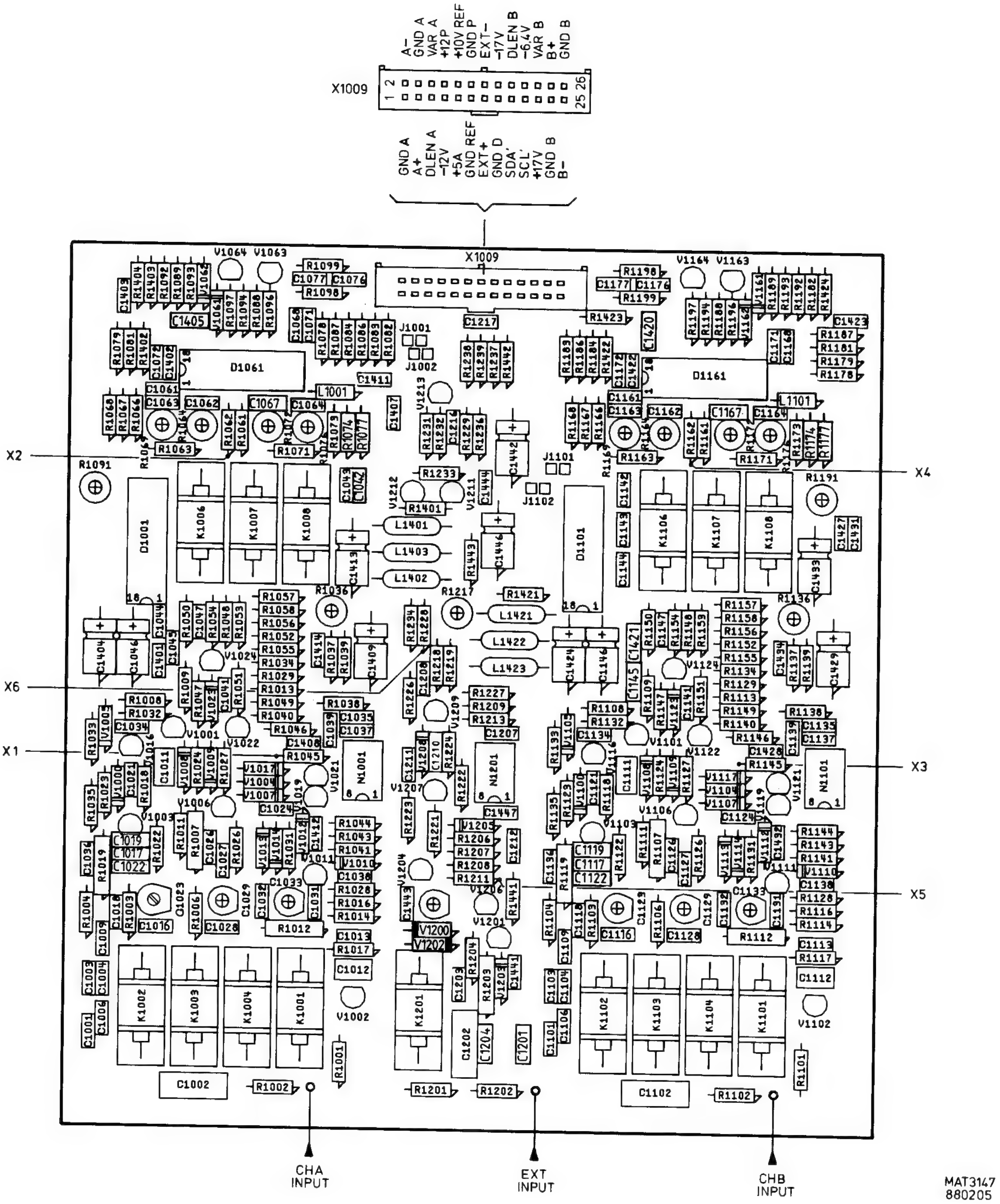


Figure 4.5 Attenuator unit p.c.b.

4. ATTENUATOR UNIT (A1)

4.1 VERTICAL ATTENUATORS

The A and B channel attenuators are identical: therefore only channel A is described.

All relay and FET switches are controlled by the microcomputer via the I^2C bus. The TEA 1017 converts this serial DATA into the parallel control signals for all relay or FET switches. A list of the control lines for all attenuator settings is given in the table below.

	X1H	X10H	X100H	X1F	X10F	X100F	X1L	X2,5L	X5L	X1/X10
2mV	●			●			●			●
5mV	●			●				●		●
10mV	●			●					●	●
20mV	●			●			●			
50mV	●			●				●		
1V	●			●					●	
2V		●			●		●			
5V		●			●			●		
1V		●			●				●	
2V			●			●	●			
5V			●			●		●		
10V			●			●			●	

MAT 2227

Figure 4.1 Table of attenuator settings

The channel A attenuator consists of in five stages:

Input coupling, where depending on the relay K1001 position, the input signal can either be d.c.-coupled (relay activated) or a.c.-coupled (relay not activated).

High impedance attenuator with three attenuator stages for the x1, x10 and x100 attenuation. The l.f. part of each stage is split via a resistor divider and routed via N1001 and V1019 to the output of this stage, where it is re-connected with the h.f. part of the input signal. Potentiometers R1036 (TRACE jump) serves as a offset compensation for N1001.

	RELAY	FET	TRIMMER FOR L.F. SQUARE WAVE	L.F. RESISTOR DIVIDER
x 1	K1004	V1011	C1033	--
x 10	K1003	V1006	C1029	R1007-R1011
x100	K1002	V1003	C1023	R1019-R1004

Note that, when "0" (GND-A) is selected, the output is connected to ground via FET V1016 and all other relay- and FET switches are switched off.

The impedance converter serves as an inverting buffer circuit for the high impedance attenuator. For the l.f.-feedback the output signal of this stage is routed to the l.f. summation point N1001-2.

The low impedance attenuator reduces the gain by x1, x2.5 and x5, depending on which relay is activated.

	RELAY	RESISTOR DIVIDER
x1	K1006	--
x2.5	K1007	R1053 vs R1056, R1057 and R1058
x5	K1008	R1053, R1056 and R1057 vs R1058

The continuous circuit (OQ0203), the differential input voltages of which are fed to pins 4 and 5.
This stage comprises the following functions:

- Continuously variable control (pin 11).
- Gain x1 (pin 2 and 3) with offset adjustment R1064 (R1164) and gain adjustment R1069 (R1169).
- Gain x10 (pin 6 and 7) with offset adjusting R1072 (R1172) and gain adjustment R1076 (R1176).
- x1/x10 control, (pin 10) to select the 2,5 and 10 mV/DIV settings.

The differential output current from pin 13 and pin 14 is routed via a common-base circuit V1063, V1064 and applied to the pre-amplifier unit.

4.2 EXTERNAL INPUT

The external input can be subdivided into four stages:

Input coupling, basically similar to the ch.A input coupling.

High impedance attenuator for the x1 attenuator only, where the l.f. square-wave can be adjusted with trimmer C1206. The l.f. part is routed to the summation point N1201-2. R1217 serves as an offset compensation for N1201. For l.f.-feedback the output of the impedance converter is also routed to this summation point.
Note that the output of this stage is also a reconstituted version of the input signal.

Impedance converter, is basic similar to the ch.A impedance converter.

The differential amplifier V1211, V1212 converts the voltage from emitter-follower V1209 into the differential current signals EXT+ and EXT-. This signal is applied to the pre-amplifier unit and serves as external trigger signal or as an external deflection signal.
The current for this stage is applied from current source V1213.

3. INTRODUCTION TO CIRCUIT DESCRIPTION AND BLOCK DIAGRAM DESCRIPTION

3.1 INTRODUCTION TO CIRCUIT DESCRIPTION

The functioning of the circuits is described per printed-circuit board (p.c.b.). For every p.c.b. a separate chapter (4-10) is available containing the lay out of the p.c.b., the associated circuit diagram(s) and the circuit description.

Location of electrical parts

The item numbers of C...., R...., V...., N...., D.... and K.... have been divided into groups which relate to the circuit and the printed-circuit board according to the following table:

Item number	unit no.	Printed-circuit board	Figure
1000-1999	A1	Attenuator unit	4
2000-2999	A2	Pre-amplifier unit	5
3000-3999	A3	XYZ amplifier unit	6
4000-4999	A4	Time-base unit	7
5000-5999	A5	CRT control unit	8
6000-6999	A6	Power supply	9
7000-7999	A7	Front unit	10
8000-8999	A8	LCD unit	10

3.2 BLOCK DIAGRAM DESCRIPTION (see figure 3.1).

3.2.1 Introduction

This block diagram description is based around all the important functional blocks and their interconnections. The interconnections between all p.c.b.'s are given in the interconnection diagram of figure 14.5. In order to assist in cross-reference with the circuit diagrams, the blocks include the item numbers of the active components they contain.
Furthermore, the blocks are grouped together per printed-circuit board, or a part of it. To facilitate reference, the names of the functional blocks are given in text in CAPITALS.
Signal waveforms are also indicated at block interconnections where useful.
In this instrument almost all the switches (UP-DOWN controls, softkeys and potentiometer UNCAL switches) influence the oscilloscope circuits via a microcomputer (uC) system.

3.2.2 Control unit

Because the functional description of the control unit (see chapter 10) is almost simular to the blockdiagram description, no specific attention is given in this chapter to this unit.

3.2.3 Attenuator unit

The vertical channels A and B for the signals to be displayed are identical. Each channel comprises an input SIGNAL COUPLING for AC/DC, a HIGH IMPEDANCE ATTENUATOR which gives a grounded input or a signal attenuation of x1-x10 or x100, an IMPEDANCE CONVERTER, a LOW IMPEDANCE ATTENUATOR which gives signal attenuation of x1-x2,5 or x5 and a GAIN x1-x10
AMPLIFIER block, incorporated with the CONTINUOUS CIRCUIT. This block has a variable gain, influenced by the front-panel VAR control. The gain is also increased by x10 in order to obtain 2-5 and 10mV settings.

Similar to the vertical channels, the external channel attenuator also has an input SIGNAL COUPLING, HIGH IMPEDANCE ATTENUATOR and IMPEDANCE CONVERTER in line. However, the external channel has only x1 attenuation and no LOW IMPEDANCE ATTENUATOR. The output of the external channel is fed to both MTB and DTB TRIGGER PRE-AMPLIFIERS.

All blocks that are capable of working in different modes are controlled by the control A or control B signals. These signals are generated by the CH.A CONTROL or CH.B CONTROL blocks.

3.2.4 Pre-amplifier unit

This unit incorporates the signal splitters for the vertical channels A and B, the trigger view amplifier, the trigger circuits for the MTB and DTB and the chopper oscillator circuit. All these functions are controlled by the control XYP and control XYA signals, generated by the X-Y CONTROL blocks.

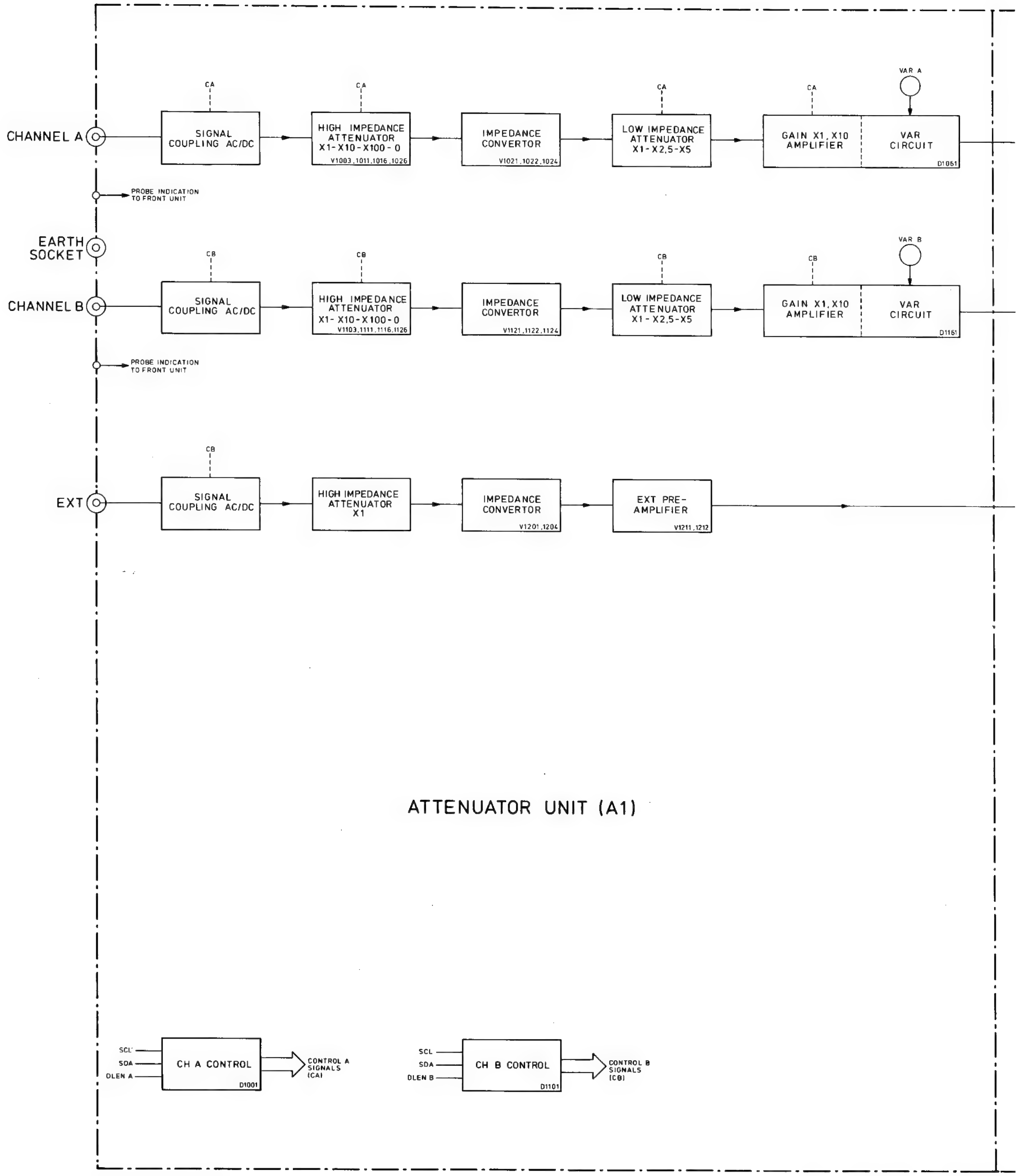
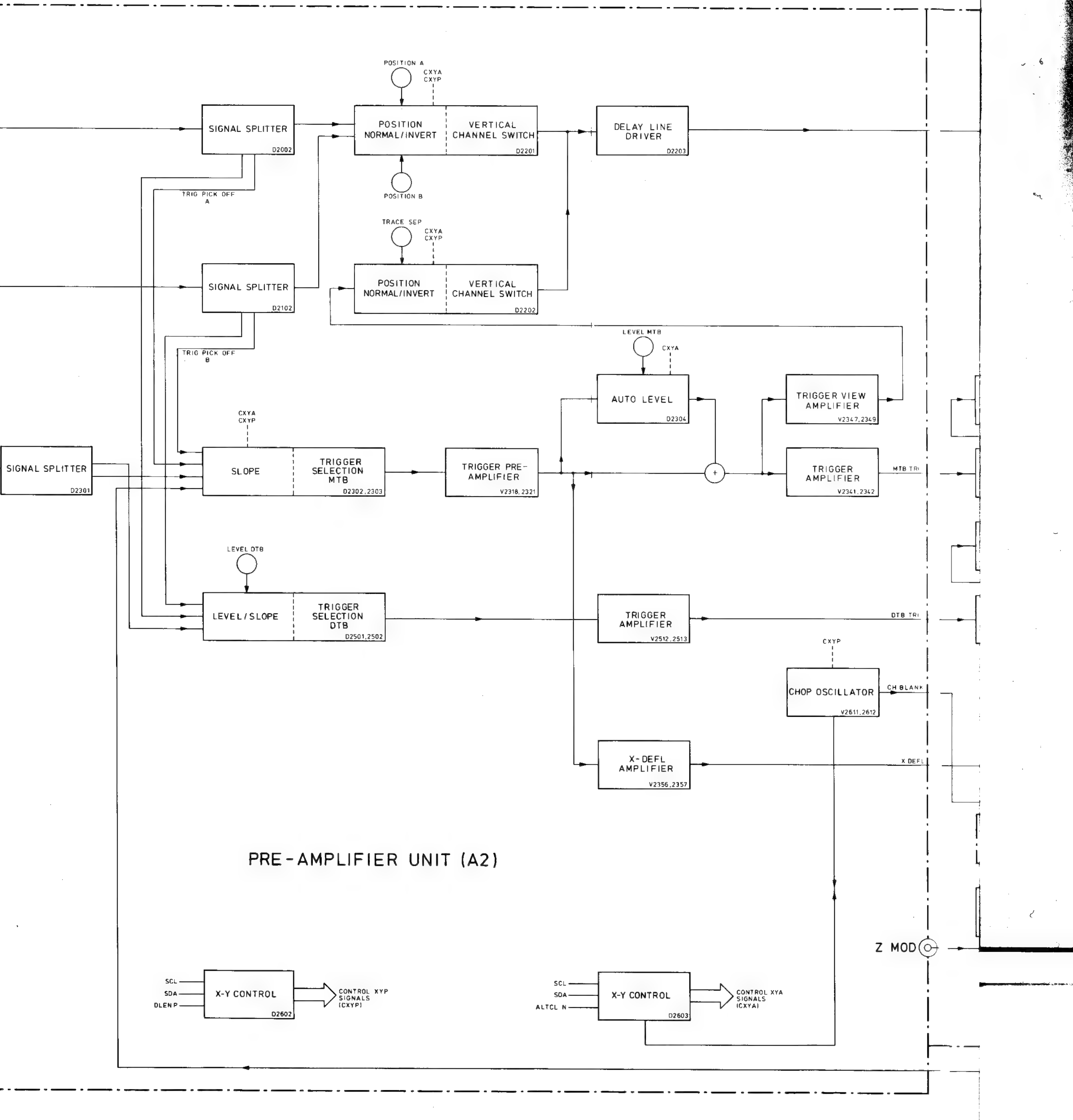
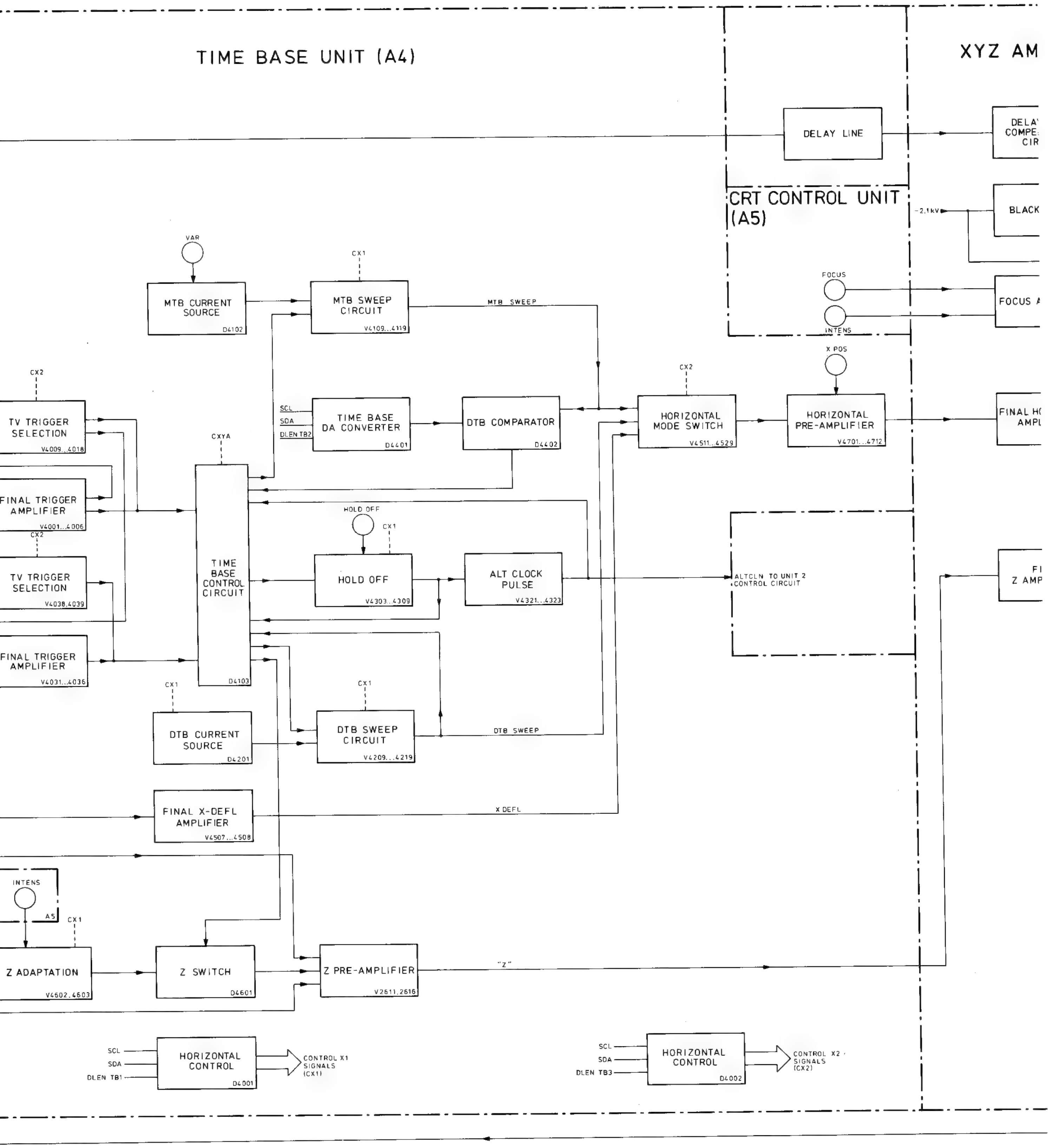


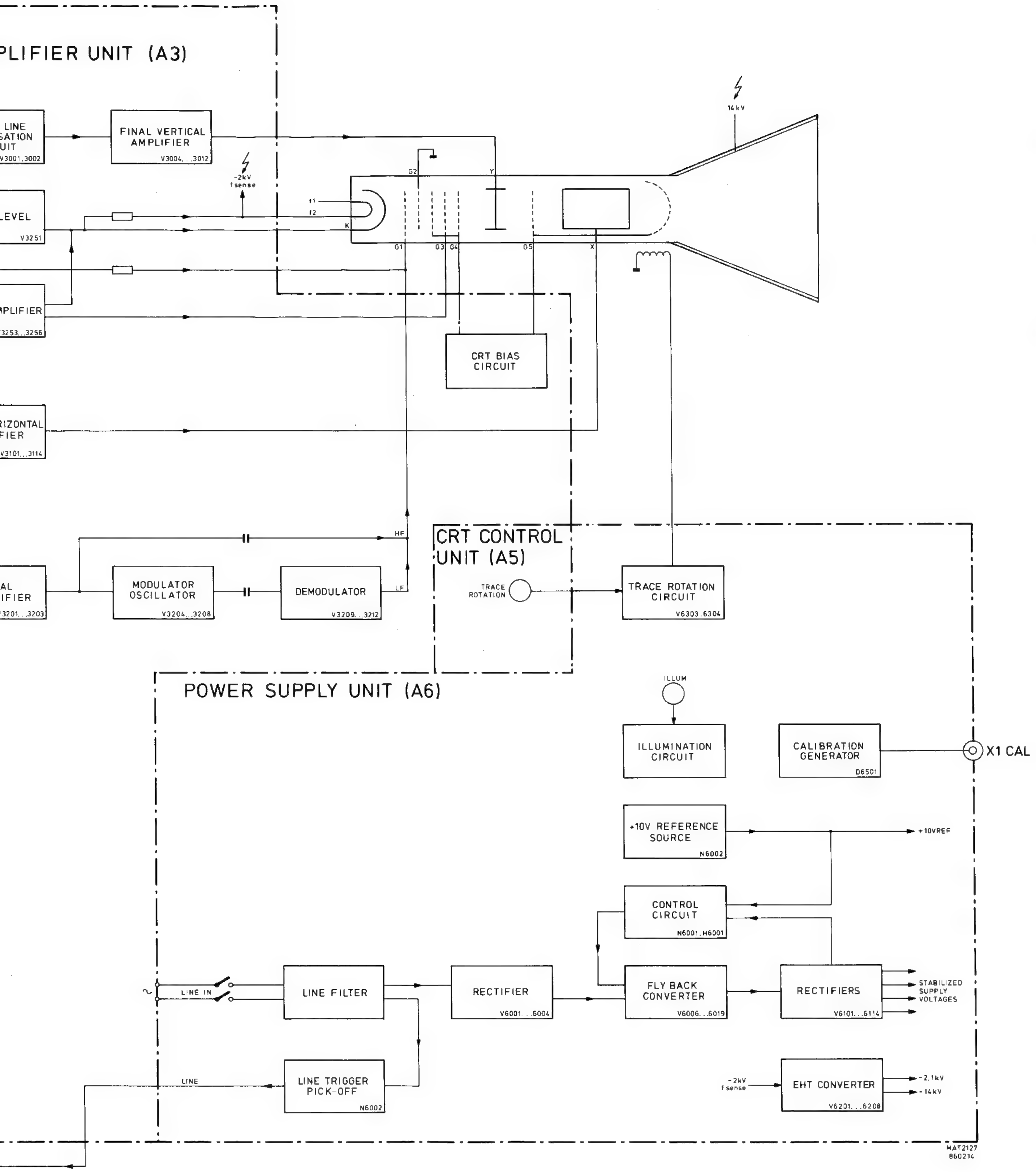
Figure 3.1 Block diagram



POSITION A
CXYA
CXYP
SIGNAL SPLITTER
D2002
POSITION NORMAL/INVERT
VERTICAL CHANNEL SWITCH
D2201
DELAY LINE DRIVER
D2203
POSITION B
TRIG PICK OFF A
TRACE SEP
SIGNAL SPLITTER
D2102
POSITION NORMAL/INVERT
VERTICAL CHANNEL SWITCH
D2202
TRIG PICK OFF B
LEVEL MTB
AUTO LEVEL
D2304
TRIGGER VIEW AMPLIFIER
V2347, 2349
SIGNAL SPLITTER
D2301
SLOPE
TRIGGER SELECTION MTB
D2302, 2303
TRIGGER PRE-AMPLIFIER
V2318, 2321
TRIGGER AMPLIFIER
V2341, 2342
MTB TRI
LEVEL DTB
LEVEL/SLOPE
TRIGGER SELECTION DTB
D2501, 2502
TRIGGER AMPLIFIER
V2512, 2513
DTB TRI
CHOP OSCILLATOR
V2611, 2612
CH BLANK
X-DEFL AMPLIFIER
V2356, 2357
X DEFL
PRE-AMPLIFIER UNIT (A2)
Z MOD
SCL
SDA
DLENP
X-Y CONTROL
D2602
CONTROL XYP SIGNALS (CXYP)
SCL
SDA
ALTCL N
X-Y CONTROL
D2603
CONTROL XYA SIGNALS (CXYA)



TIME BASE UNIT (A4)
XYZ AM
CRT CONTROL UNIT (A5)
DELAY LINE
DELAY COMPE CIR
BLACK
-2,1kV
FOCUS
INTENS
FOCUS A
X POS
MTB CURRENT SOURCE
D4102
VAR
CX1
MTB SWEEP CIRCUIT
V4109...4119
MTB SWEEP
TIME BASE DA CONVERTER
D4401
SCL
SDA
DLEN TB2
DTB COMPARATOR
D4402
HORIZONTAL MODE SWITCH
V4511...4529
CX2
HORIZONTAL PRE-AMPLIFIER
V4701...4712
FINAL HO AMPL
TV TRIGGER SELECTION
V4009...4018
FINAL TRIGGER AMPLIFIER
V4001...4006
TV TRIGGER SELECTION
V4038,4039
FINAL TRIGGER AMPLIFIER
V4031...4036
CXYA
TIME BASE CONTROL CIRCUIT
D4103
HOLD OFF
HOLD OFF
V4303...4309
ALT CLOCK PULSE
V4321...4323
ALTCLN TO UNIT 2 CONTROL CIRCUIT
FI Z AMP
DTB CURRENT SOURCE
D4201
DTB SWEEP CIRCUIT
V4209...4219
DTB SWEEP
FINAL X-DEFL AMPLIFIER
V4507...4508
X DEFL
INTENS
A5
Z ADAPTATION
V4602,4603
Z SWITCH
D4601
Z PRE-AMPLIFIER
V2611,2616
"Z"
HORIZONTAL CONTROL
D4001
SCL
SDA
DLEN TB1
CONTROL X1 SIGNALS (CX1)
HORIZONTAL CONTROL
D4002
DLEN TB3
CONTROL X2 SIGNALS (CX2)



PLIFIER UNIT (A3)
LINE
GATION
UIT
V3001,3002
FINAL VERTICAL
AMPLIFIER
V3004...3012
-2kV
f sense
14kV
LEVEL
V3251
MPLIFIER
V3253...3256
RIZONTAL
FIER
V3101...3114
CRT BIAS
CIRCUIT
AL
IFIER
3201...3203
MODULATOR
OSCILLATOR
V3204...3208
DEMODULATOR
V3209...3212
HF
LF
CRT CONTROL
UNIT (A5)
TRACE
ROTATION
TRACE ROTATION
CIRCUIT
V6303,6304
POWER SUPPLY UNIT (A6)
ILLUM
ILLUMINATION
CIRCUIT
CALIBRATION
GENERATOR
D6501
X1 CAL
+10V REFERENCE
SOURCE
N6002
+10VREF
CONTROL
CIRCUIT
N6001,H6001
LINE IN
LINE FILTER
RECTIFIER
V6001...6004
FLY BACK
CONVERTER
V6006...6019
RECTIFIERS
V6101...6114
STABILIZED
SUPPLY
VOLTAGES
LINE
LINE TRIGGER
PICK-OFF
N6002
-2kV
f sense
EHT CONVERTER
V6201...6208
-2,1kV
-14kV
MAT2127
860214

* Vertical channels A and B:

Both channels are completely identical and receive their input signals from the ATTENUATOR UNIT. This signal is applied to the SIGNAL SPLITTER, which has three outputs:

- two outputs applied to the SLOPE/TRIGGER SELECTIONS for MTB or DTB triggering.
- a third output routed to the POSITION/NORMAL-INVERT block.

This block is incorporated with the VERTICAL CHANNEL SWITCH in a single IC. Vertical shift of the displayed signal is achieved by the front-panel POSITION control. The output of this block and the output of the TRIGGER VIEW channel are routed via the DELAY LINE DRIVER to the DELAY LINE. The TRIGGER VIEW channel enables display of the MTB trigger source and can be used as a third vertical channel with limited specifications. The front-panel TRACE SEP control influences the position of the trace of the DTB signals related to the trace of the MTB signal.

* MTB trigger circuit:

The SLOPE/TRIGGER SELECTION block receives a trigger signal from one of the vertical channels A or B, from the EXT SIGNAL SPLITTER or from the LINE TRIGGER PICK-OFF. Inverting of the trigger signal is controlled by the CXYA signalsINVAM and INVBM to obtain the MTB slope function.Routed via the TRIGGER PRE-AMPLIFIER, block the signal is split up into three different paths:

- after summation of the LEVEL signal, direct to the TRIGGER AMPLIFIER
- to the AUTO LEVEL block. This block contains the different trigger facilities and levelling of the trigger signal is influenced by the front-panel LEVEL control. The output of this path is routed again to the summation point to influence the direct trigger signal.
- to the X-DEFL AMPLIFIER for X-deflection facility. This block incorporates a phase correction circuit for the X-Y display.

  The TRIGGER AMPLIFIER feeds the MTB trigger signal to the time-base unit. The trigger signal from the summation point is also routed via the TRIGGER VIEW AMPLIFIER to the vertical CHANNEL SWITCH stage to display this signal.

* DTB trigger circuit:

Basically, for triggering purposes this circuit is identical to the MTB trigger circuit. This circuit also has a SLOPE/TRIGGER SELECTION and TRIGGER AMPLIFIER block. However, the DTB trigger circuit has no LINE trigger or AUTO LEVEL facility. The LEVEL control directly influences the SLOPE/TRIGGER SELECTION block.

* Chopper oscillator circuit:

A square-wave signal for chopper blanking and vertical switching is generated in the CHOP OSCILLATOR. For chopper blanking the signal is routed to the Z PRE-AMPLIFIER on the time-base unit.

3.2.5 Time-base unit

This unit incorporates the main time-base (MTB), the delayed time-base (DTB), the horizontal amplifier and the Z amplifier circuit. All functions are controlled by the CX1 and CX2 signals, generated by the HORIZONTAL CONTROL CIRCUIT blocks.

* Main time-base (MTB):

The MTB trigger signal can be either directly routed to the TIME-BASE CONTROL CIRCUIT or first routed via the TV TRIGGER SELECTION for the TV trigger coupling. When in the AUTO mode, in the absence of trigger signals, the MTB will be free running.

The MTB CURRENT SOURCE applies the sawtooth charging current to the MTB sweep circuit. This block generates the MTB sawtooth signal, which is routed to the HORIZONTAL DISPLAY MODE SWITCH.

The HOLD OFF and the ALT CLOCK PULSE blocks are also under control of the TIME BASE CONTROL CIRCUIT. Hold off time is varied by the front-panel HOLD OFF control. The output of the HOLD OFF block is routed to the TIME-BASE CONTROL CIRCUIT again.

The ALTCLN-pulse is applied to the PRE-AMPLIFIER UNIT.

3.2.6 XYZ unit

This unit comprises the final amplifiers for the vertical (Y) and horizontal (X) deflection and for the blanking (Z) circuit. In addition to this, the CRT control circuits are also incorporated in the unit.

* Final vertical amplifier:

The output signal from the pre-amplifier unit is first routed via the DELAY LINE to give sufficient delay to ensure that the steep leading edges of fast signals are displayed and then fed to the DELAY LINE COMPENSATION. This block compensates the signal for distortion originating in the DELAY LINE before it is applied to the FINAL VERTICAL AMPLIFIER. The output of the FINAL VERTICAL AMPLIFIER feeds the vertical deflection plates of the CRT.

* Final horizontal amplifier:

The horizontal deflection signal is routed to the FINAL HORIZONTAL AMPLIFIER, the output of which feeds the horizontal deflection plates of the CRT.

* Blanking circuit:

The output signal from the Z PRE-AMPLIFIER of the time-base unit, that determines trace blanking or unblanking and modulation is routed to the FINAL Z-AMPLIFIER. After amplification the blanking signal is split into two paths:

- the h.f. signals are fed via a high voltage capacitor to grid G1 of the CRT.
- the l.f. signals are used to modulate the amplitude of an oscillator wave-form, which then passes via another high voltage capacitor and is demodulated in the DEMODULATOR block to retrieve the original signal.

Note that the original h.f. and l.f. signals are again recombined on the grid G1.

* CRT control circuits:

The FOCUS AMPLIFIER block is influenced by both front-panel FOCUS and INTENS controls to provide a focus that is independent of the intensity, and drives the focusing grid G3 of the CRT.

The -100 V BLACK LEVEL block provides the correct presetting of the cathode voltage.

The CRT BIAS gives a d.c. voltage to the grids G4 and G5 to provide an optional adjustment for geometry and astigmatism.

3.2.7 Power supply unit

The mains input voltage is filtered and then applied to the RECTIFIER block to obtain a d.c. voltage source. Another output of the LINE FILTER block is routed via the LINE TRIGGER PICK-OFF and serves as a MTB LINE trigger signal. The rectified mains source is routed to the FLYBACK CONVERTER, which generates the necessary voltages for the oscilloscope circuits. Each supply voltage is rectified in the RECTIFIERS block.
The LOW-voltage supplies are stabilized by the CONTROL circuit to the converter.
The +10 V REF supply serves as a low-voltage reference and is generated in the +10 V REFERENCE source block. This reference voltage is also fed to the different circuits on the power supply or in the oscilloscope.

The EHT CONVERTER generates the -14 kV for the post-accelerator anode of the CRT and the -2 kV for the cathode circuits.

* Auxiliary circuits:

The CALIBRATION GENERATOR generates the CAL voltage, which is applied to the output socket X1. The CAL voltage has a 1,2 V p-p level with a frequency of 2kHz square wave.

The ILLUMINATION CIRCUIT determines the amount of current passed to the graticule illumination lamp of the CRT controlled by the ILLUM control on the front-panel.

The TRACE ROTATION CIRCUIT determines the strength and sense of the current passed to the trace rotation coil around the neck of the CRT. The current is influenced by the front-panel screwdriver operated TRACE ROT control.

5. PRE-AMPLIFIER UNIT (A2)

The pre-amplifier unit consists of:

- Vertical pre-amplifier
- MTB trigger pre-amplifier
- DTB trigger pre-amplifier
- Pre-amplifier control, incl. CHOPPER oscillator.

All control pulses for this unit are generated by the pre-amplifier control circuit, via the I^2C bus (see section 5.4).

5.1 VERTICAL PRE-AMPLIFIER

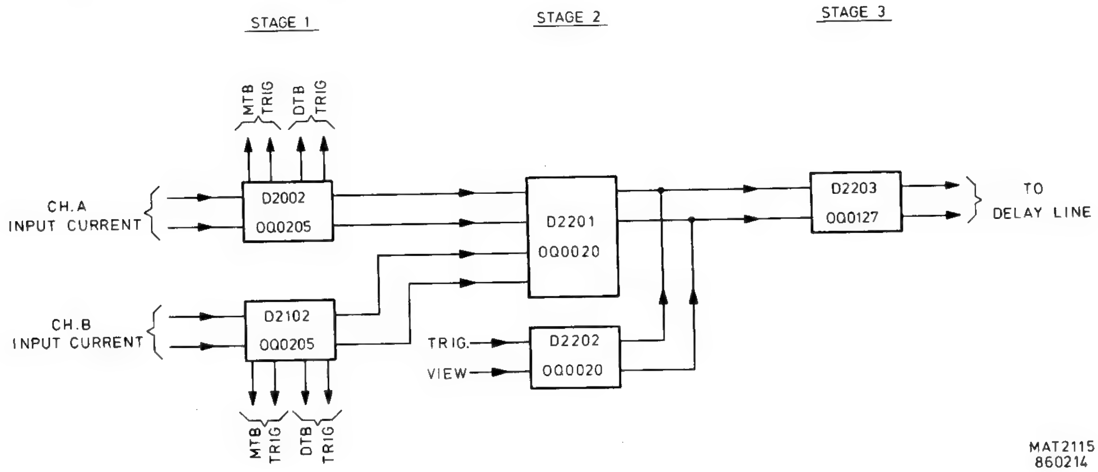


Figure 5.1 The three stages of the vertical pre-amplifier

The vertical pre-amplifier consists of three stages.

The signal splitter (Q0205) receives its input signal for channel A (B) from the attenuator unit and copies this signal into three identical differential output current signals for:

- Vertical channel (pin 7 and 10)
- MTB triggering (pin 5 and 12), see section 5.2.
- DTB triggering (pin 4 and 13), see section 5.3.

Stage 2 (OQ0020) consists of two integrated circuits D2201 and D2202, connected in parallel and serves as a vertical channel switch. The switch selection is as follows:

	D2201 pin 10	D2201 pin 11	D2202 pin 10
A	1	0	0
B	0	1	0
TRIG VIEW	0	0	1
ADD	1	1	0

Further, all possible 2, 3, or 4 channel combinations are possible in alternated or chopped display (see also section 5.4).

This stage comprises the following functions:

- Position control POS A R7006 on D2201-1 for ch. A and POS B R7008 on D2201-8 for ch. B.
- Channel B normal/invert (high is INVERT) on D2201-7.
  (The balance between normal/invert can be adjusted with R2212).
- Trigger view invert (high is INVERT) on D2202-2.
- Trace separation control with R7013 on D2202-8.

Stage 3 (D2203) serves as delay line driver where the output current of both OQ0020 is converted into voltage signal applied to the delay line. The current for this stage and for D2201 and D2202 is fed via R2231 and R2246.
The current regulation for the common-mode circuit is achieved by transistor D2203 (12, 13, 14).

5.2 MTB TRIGGER PRE-AMPLIFIER

Trigger possibilities are:

	Signal name	Signal routed to	Selected by: name	Selected by: routed to	inverted by: name	inverted by: routed to
ch. A	TRAM+, TRAM-	D2302(3,4)	AM	D2302(10)	INVAM	D2302(2)
ch. B	TRBM+, TRBM-	D2302(5,6)	BM	D2302(11)	INVBM	D2302(7)
EXTERNAL	EXT-, EXT+	D2303(3,4)	EXTM	D2303(10)	INVAM	D2303(2)
line	LINE	D2303(5)	LNM	D2303(11)	INVAM	D2303(7)

D2301 serves as a signal splitter and receives its input signal from the attenuator unit. This input current signal is copied into two identical differential output current signals for:

- EXT MTB signal (pin 6 and 11)
- EXT DTB signal (pin 7 and 10), (see Section 5.3).

The symmetrical output currents from D2302 (13, 14) and D2303 (13, 14) are converted into a symmetrical voltage again in the common-base circuit V2316, V2319 followed by a shunt feedback circuit V2318 and V2321. Note that the sensitivity at the collectors of V2318 and V2321 is 110 mV/DIV.

At this point the signal path is divided into:

- a trigger path, fed to both V2333 and V2334, where depending on the current to the base, levelling of the trigger signal is obtained. Two separate series feedback circuits take care of voltage-to-current conversion:

  * V2341 and V2342 for main time-base triggering.
    The trigger output signal, TRIGM- and TRIGM+ are fed to the time-base unit A4.
  * V2347 and V2349 for trigger view.
    This symmetrical output can be balanced by potentiometer R2407 (Trig view BAL).
    The TRIGV+ and TRIGV- signals are fed to D2202 (3-4).

Integrated circuit D2304 serves as an auto level circuit.
The following functions are possible.

a. Peak-peak

In this case the amplitude of the trigger signal applied to D2304 (3,7) is measured by peak-peak detectors on D2304 (2,4,6,8). The output current from D2304 (14,15) is dependent on the peak-peak level and is adjustable with the LEVEL control R7012, connected to D2304(1).

b. Triggering

In this case the level range is 16 div. The level is adjustable with R7012 and the current variation on D2304 (14,15) can be varied between +or- 0,6mA.

c. TV triggering

The level control is made ineffective. In TV triggering, the LEVEL must be set to a fixed value. This is done by applying a high level current to pin 1 via diode V2326.

d. Auto

In auto the signal LEVEL ZERO is high and via diode V2325 the output level D2304 (15) is asymmetrical with output level D2304 (14). Thus the maximum signal amplitude is 2 Vp-p.

- an external deflection path, routed via the series feedback circuit V2356 and V2357, the X DEFL+ and X DEFL- signals are fed to the time base unit A2.
  R2416, R2422 and C2350 gives phase correction for the X-Y display.

5.3 DTB TRIGGER PRE-AMPLIFIER

Trigger possibilities are:

	Signal name	routed to	Selected by: name	routed to	Inverted by: name	routed to
ch.A	TRAD+, TRAD-	D2501(3,4)	AD	D2501(10)	INVAD	D2501(2)
ch.B	TRBD+, TRBD-	D2501(5,6)	BD	D2501(11)	INVBD	D2501(7)
EXTERNAL	EXT+, EXT-	D2502(5,6)	EXTD	D2502(11)	INVAD	D2502(7)

Similar to the main time base triggering, signal splitter D2301 applies the EXT current to the OQ0020.

The LEVEL control R7014 is connected to D2502-1 to obtain a level range of 16 div.

The output of both integrated circuits, pin 13 and 14, are routed via a shunt feedback V2512, V2513, followed by a series feedback circuit V2514, V2516 and provide the DTB trigger signals TRIGD- and TRIGD+. These signals are fed to the time-base unit A4.

5.4 PRE-AMPLIFIER CONTROL

The pre-amplifier control converts the data from the I^2C bus (SDA and SCL), derived from the microcomputer, into the control pulses for the pre-amplifier unit. To eliminate interference the SDA and SCL lines can be switched off via D2601.

This integrated circuit serves as a digital switch, controlled by the VERT IIC line. Logic high connects the outputs D2601(4,14,15) to the input "1" contact (switched on); logic low connects the outputs to the "2" contact (switched off) and gives SDA a logic low level and SCL a logic high level.

When D2601 is switched on, the serial data information is converted into parallel control pulses via D2602 and D2603, provided that D2602 is enabled (D2602-5 is high). The control lines are active when the level of the line is high.

Output Q12-D2602(9) serves as a power up not line for D2603: when the oscilloscope is in the power-up routine, Q12 is high and resets D2603. After the power-up routine, Q12 goes low and enables D2603.

Integrated circuit D2603 relieves the microcomputer of a number of such functions as:

- trigger view
- chop/alt
- trace separation
- trigger select
- time-base select (fed to time base unit A4)

Adaptation of this I.C. to the oscilloscope version is made by the AD0 and AD1 inputs D2603(15,16).
For this oscilloscope, AD0 must be HIGH and AD1 must be LOW.

Timing for alternate and chopped mode is derived by the ALTCLN and CHOPCL pulses.

The chopper oscillator formed by V2611 and V2612 supplies a square wave voltage of 1,5 Vp-p with a frequency of 1 MHz.

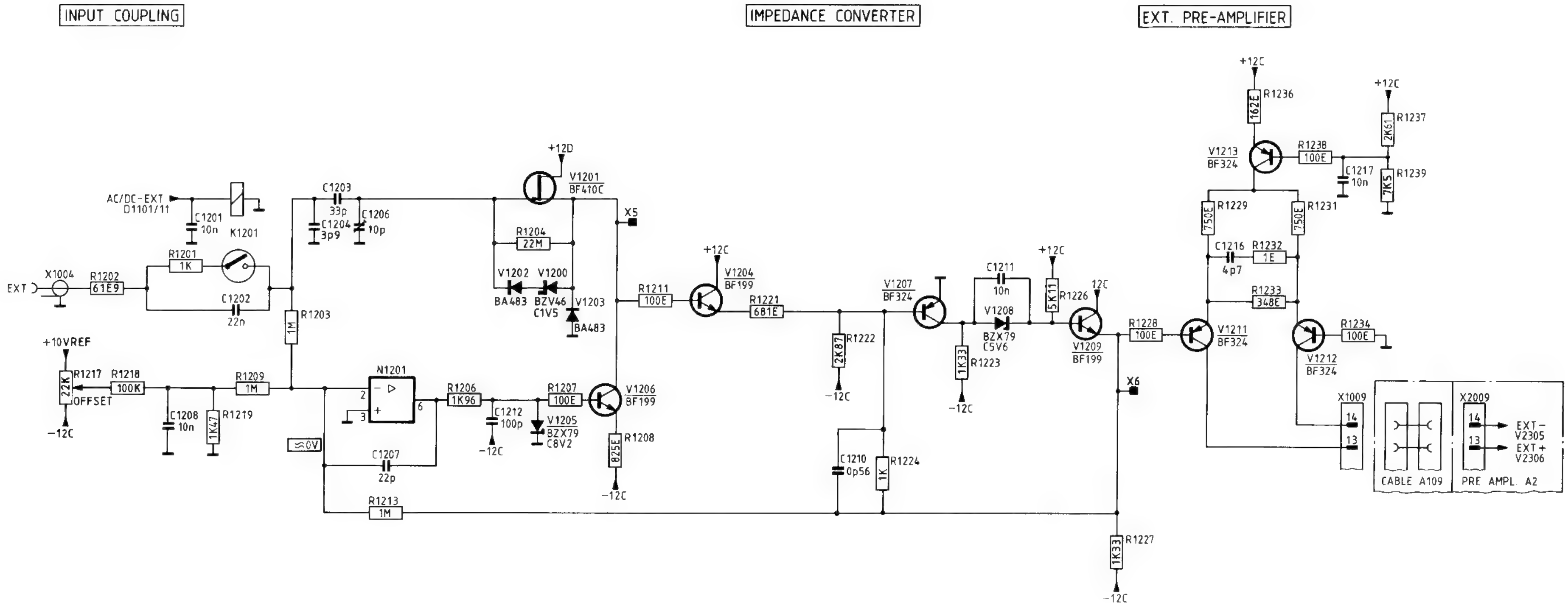
This frequency is defined by two current loops:

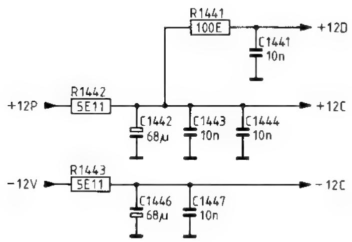
- I1 is determined by: V2612(c-e), C2611, R2627 and R2625.
- I2 is determined by: V2611(c-e), C2611, R2628 and R2625.

The duty cycle (I1/I1+I2) is 12% approx.

The square wave on the collector of V2612 serves as a chopper clock pulse for D2603 and gives a 500 kHz display for 2 channels CHOP, 333 kHz display for 3 channels CHOP and 250 kHz for 4 channels CHOP (A-B-TRIG VIEW-ADD).

Note that D2603(8) serves as the chopper switch, which is high when the CHOP softkey is depressed.





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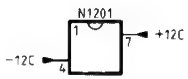


MAT3171
880212

Figure 4.6 Circuit diagram of attenuator, EXT

14.5 TROUBLE SHOOTING

14.5.1 Introduction

The following information is provided to facilitate trouble shooting. Information contained in other sections of the manual should also be used to locate the defect. An understanding of the circuit is helpful in locating troubles, particularly where integrated circuits are used. Refer to the circuit description for this information.

14.5.2 Trouble-shooting techniques

If a fault appears, the following test sequence can be used to find the defective part:

- Check if the settings of the controls of the oscilloscope are correct. Consult the Operating Instructions.
- Check the equipment to which the oscilloscope is connected and the interconnection cables.
- Check if the oscilloscope is well-calibrated. If not, refer to section 13. "Checking and Adjusting".
- Visually check the part of the oscilloscope in which the fault is suspected. In this way, it is possible to find faults such as bad soldering connections, bad interconnection plugs and wires, damaged components or transistors and IC's that are not correctly plugged into their sockets.
- Location of the circuit part in which the fault is suspected: the symptom often indicates this part of the circuit. If the power supply is defective the symptom will appear in several circuit parts.

After having carried out the previous steps, individual components in the suspected circuit parts must be examined:

- Transistors and diodes.

Check the voltage between base and emitter (0,7 V approx. in conductive state) and the voltage between collector and emitter (0,2 V approx. in saturation) with a voltmeter or an oscilloscope. When removed from the p.c.b. it is possible to test the transistor with an ohmmeter since the base/collector junctions can be regarded as diodes. Like a normal diode, the resistance is very high in one direction and low in the other direction. When measuring take care that the current from the ohmmeter does not damage the component under test.
Replace the suspected component by a new one if you are sure that the circuit is not in such condition that the new component will be damaged.

- Integrated circuits.

In circuit, testing can be done with an oscilloscope or voltmeter. A good knowledge of the circuit part under test is essential. Therefore, first read the circuit descriptions in sections 3...10.

- Capacitors.

Leakage can be traced with an ohmmeter adjusted to its highest resistance range. When testing take care of polarity and maximum allowed voltage. An open capacitor can be checked if the response for AC signals is observed. Also a capacitance meter can used: compare the measured value with the value and tolerance indicated in the parts list

- Resistors.

Can be checked with an ohmmeter after having unsoldered one side of the resistor from the pcb. Compare the measured value with the value and tolerance indicated in the parts list.

- Coils and transformers.

An ohmmeter can be used for tracing an open circuit. Shorted or partially shorted windings can be found by checking the waveform responses when HF signals are passed through the circuit. Also an inductance meter can be used.

- Data latches.

To measure on inputs and outputs of data latches a measuring oscilloscope can be triggered by the clock signal which is connected to the clock input of the data latch.
This measurement can only be made in this way when there is an acceptable repetition time of the clock signal. A too low clock pulse repetition time results in a low intensity of the trace on the measuring oscilloscope screen.
The outputs can easily be checked by a voltmeter or oscilloscope.

14.5.3 Power-up routine

Every time the instrument is switched-on the following initialisation program is executed:

- Resetting the IIC-bus.
- Resetting D2603 (0Q 0200)
- Determinig the SLAVE-address of D2603.
- Checking if Service routine is required (if yes the program will continue with the service routine).
- Checking the "WATCH-DOG" on A7 (if HIGH, all relevant LCD-segments will be lighting for about 1 sec).
- Eventually initialisation of the IEEE-option.

If during the program-run a circuit is found to be faulty, the program stops. It is recommended to switch-off and after a few seconds switch-on again. This will reset the micro-computer controlled system automatically. If the instrument goes in the same faulty situation again, the following procedure indicates how to handle. If no faulure is found, all relevant LCD-segments will be lighting for about one second. After this the normal program is executed.

PROCEDURE:

Check the SDA and SCL lines after haved switched-on. On the SCL a clock-pulse must be present, while the SDA gives the data-information (looks like a random pulse). If one of these signals is not present, you can localize on what unit the fault exists. This can be done by first unplug connector X1009 or X2001 on resp. A1 and A2. To localize what serial-parallel conversion IC is defective, you can disconnect the solder joint in the SDA and SCL print track lead to that IC.
The following IC's can disconnected in this way: D1001, D1101, D2602, D2603, D4001, D4002, D4401.

When the instrument restarts every time again, this means the WATCHDOG is initiating the main program (see also section 10.1.4), the watchdog can be disabled. This can be done by means of the solder joint jumper on the rear of the front unit p.c.b. (near X7001).
When disabled, pin 13 of the microcomputer is set to a low level.

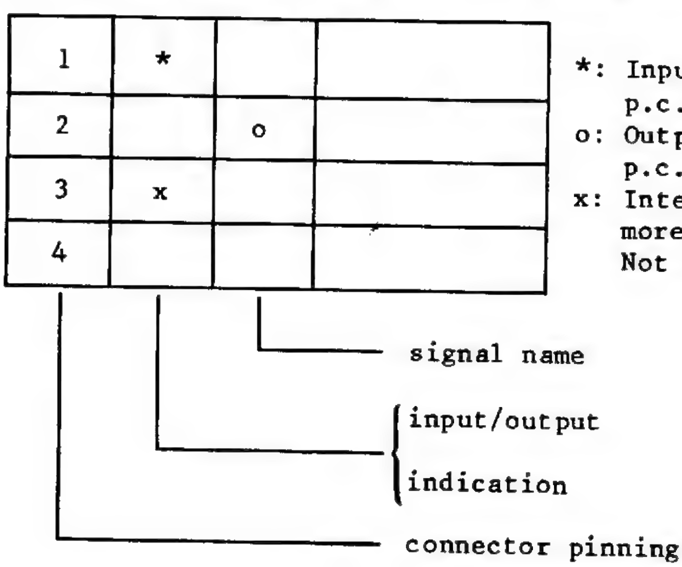
14.5.4 Trouble-shooting the power supply

To determine whether a certain fault condition is initiated by the power supply itself or by the connected oscilloscope circuits, a dummy load is listed in the table below. The table gives also an example of the resistor types that can be used to compose the dummy load. These resistors can be ordered at Concern Service.

Supply voltage	Output current	Dummy resistance and their service ordering numbers
+ 5 V	2,4 A	2,1E-12W: 3 x 8E (4822 112 21052) and 10E (4822 112 21054) in parallel.
- 6,4 V	930 mA	6,9E-6W: 8,2E (4822 112 41052) and 47E (4822 110 23072) in parallel.
+ 12 V	720 mA	17,2E-8,7W: 33E (4822 112 41067) and 39E (4822 112 43069) in parallel.
- 12 V	500 mA	24,7E-6W: 39E (4822 112 41069) and 68E (4822 112 41067) in parallel.
+ 17 V	340 mA	51E-6W: 1E (4822 110 23027) in serial with 2 x 100 E(4822 112 41081) in parallel.
- 17 V	100 mA	171E-1,7W: 270E (4822 110 43092) and 470E (4822 110 43098) in parallel.
+ 48 V	140 mA	341E-7W: 330E (4822 112 41094) in serial with 12E(4822 110 23056).
- 48 V	40 mA	1k22-2W: 2k2 (4822 110 23116) and 2k7 (4822 110 23118) in parallel.

14.5.5 P.c.b. interconnections

Figure 14.5 gives a survey of all interconnections between the p.b.c.'s and to the CRT. Also the interconnections between the connectors on board level is given in this diagram.
An explanation of the connector indication is given below:



*: Input signal for the related p.c.b.
o: Output signal for the related p.c.b.
x: Interconnection between two or more sockets of the p.c.b.
Not used on the related p.c.b.

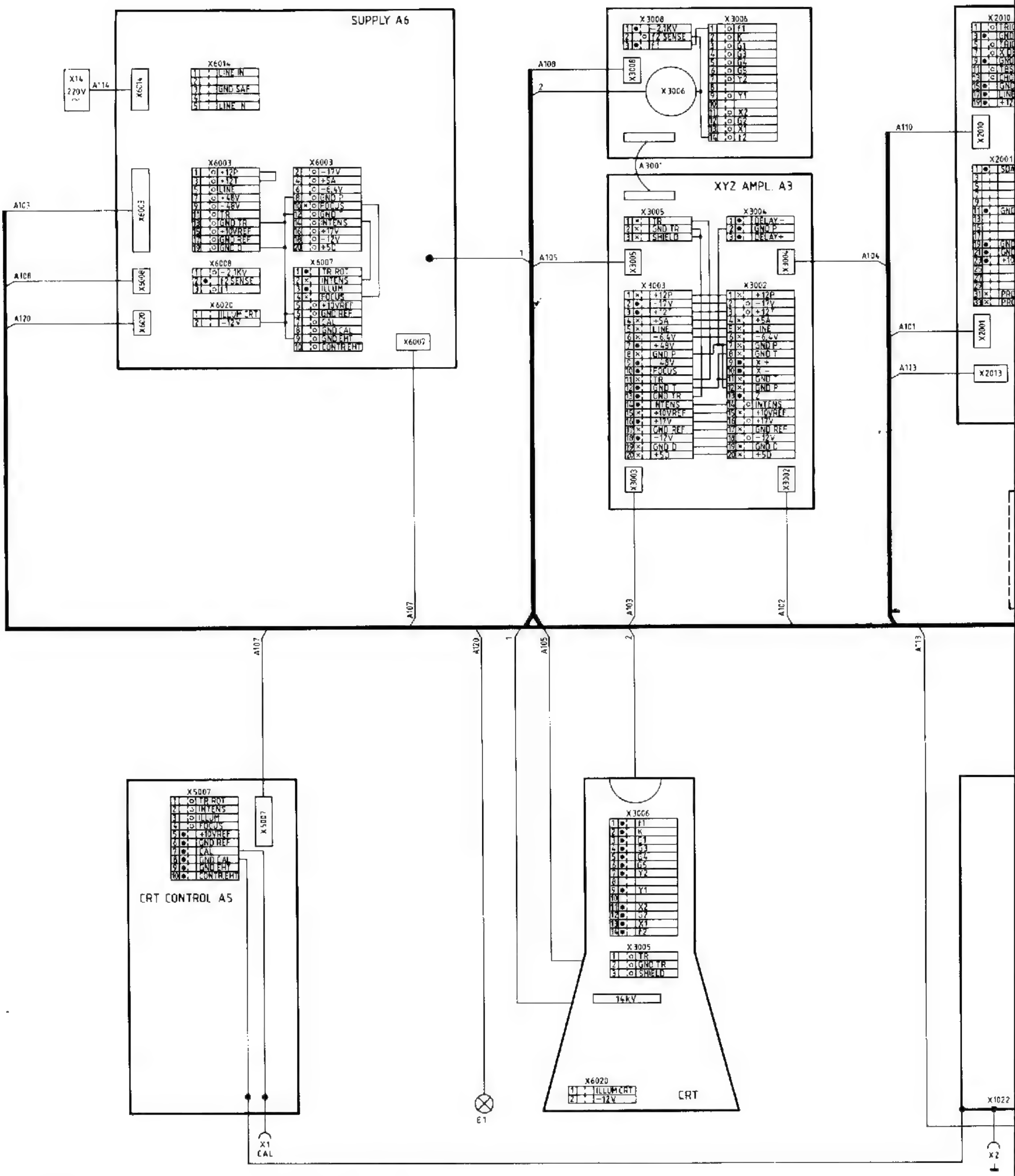
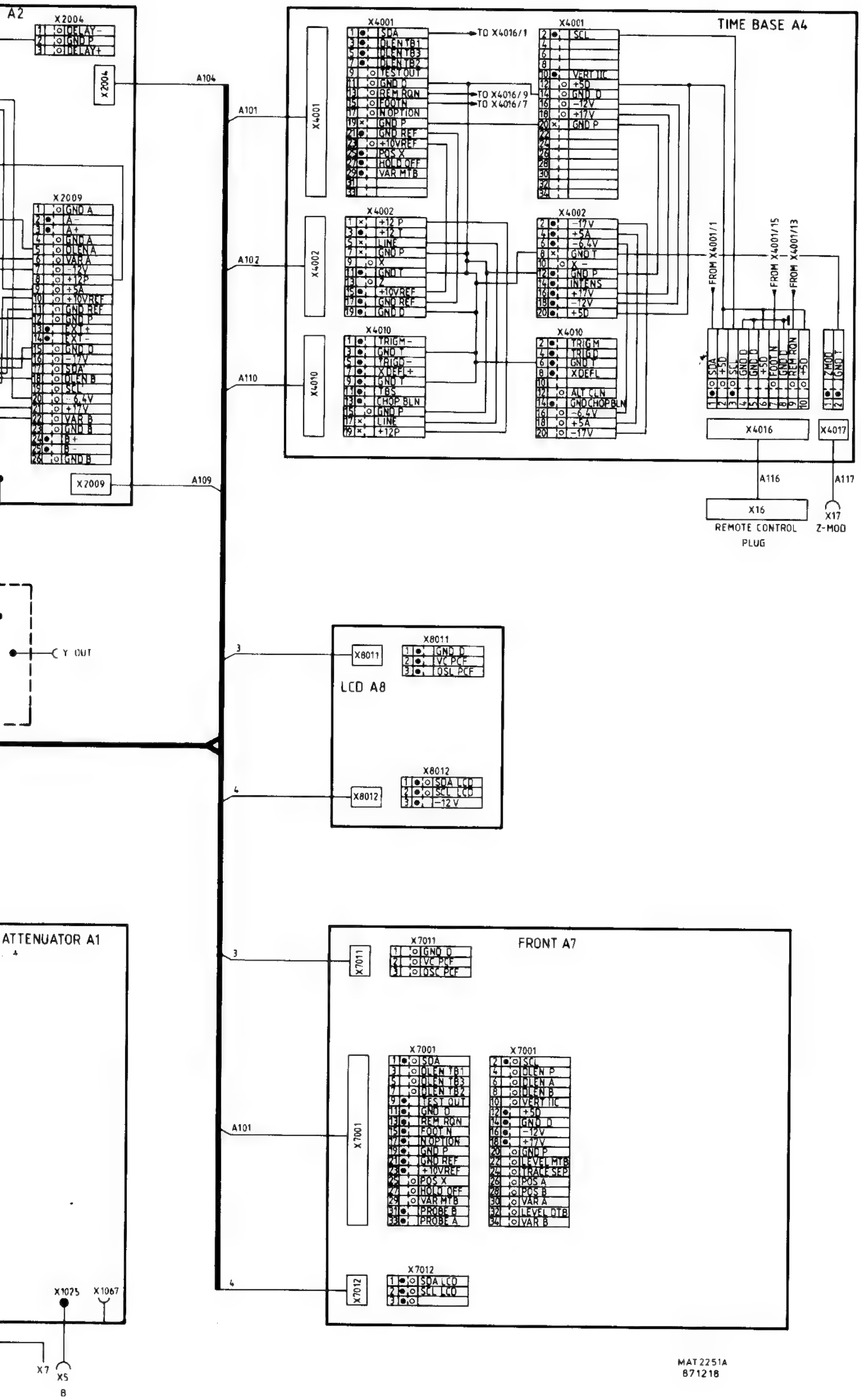
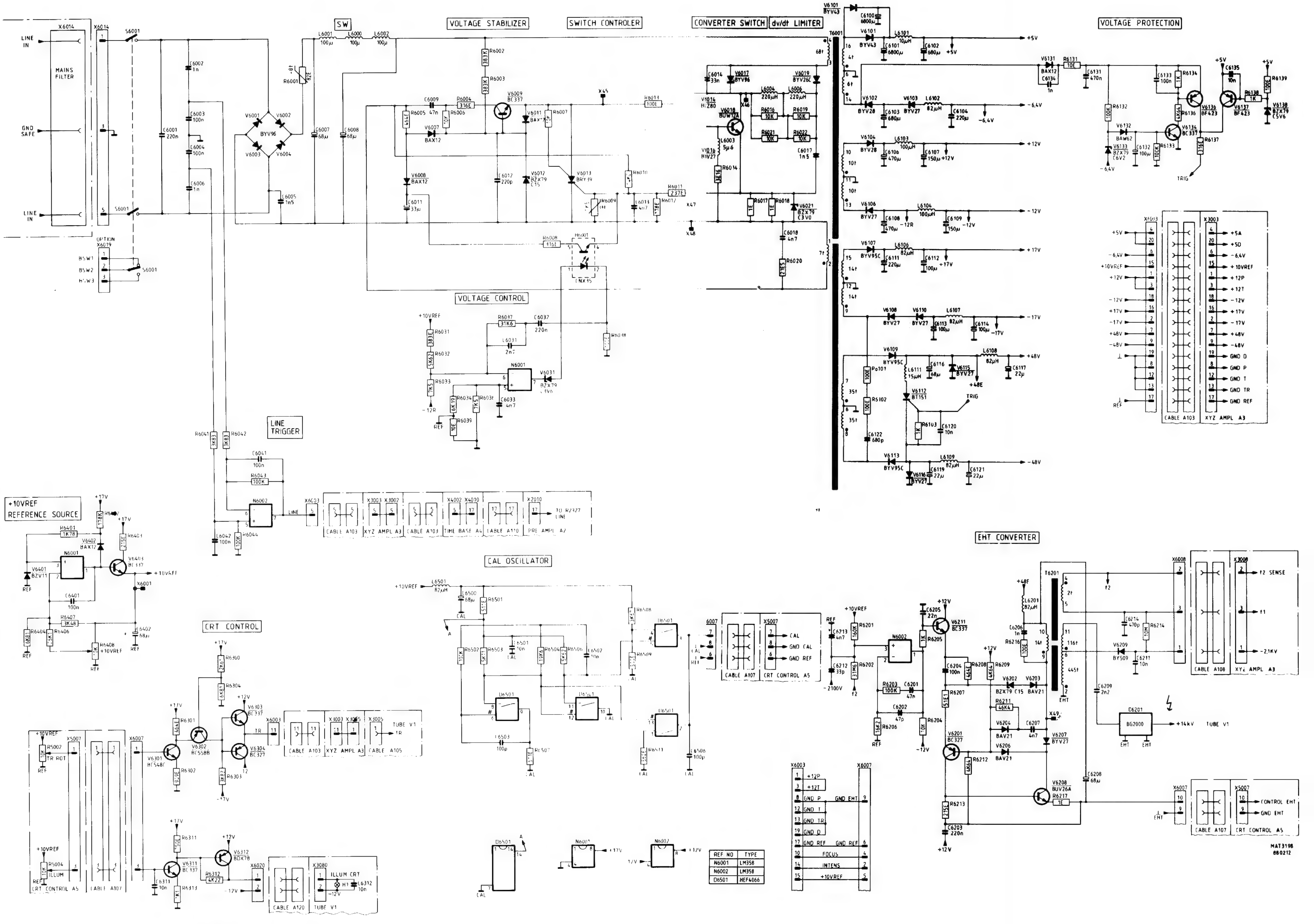


Figure 14.5 P.c.b. interconnections

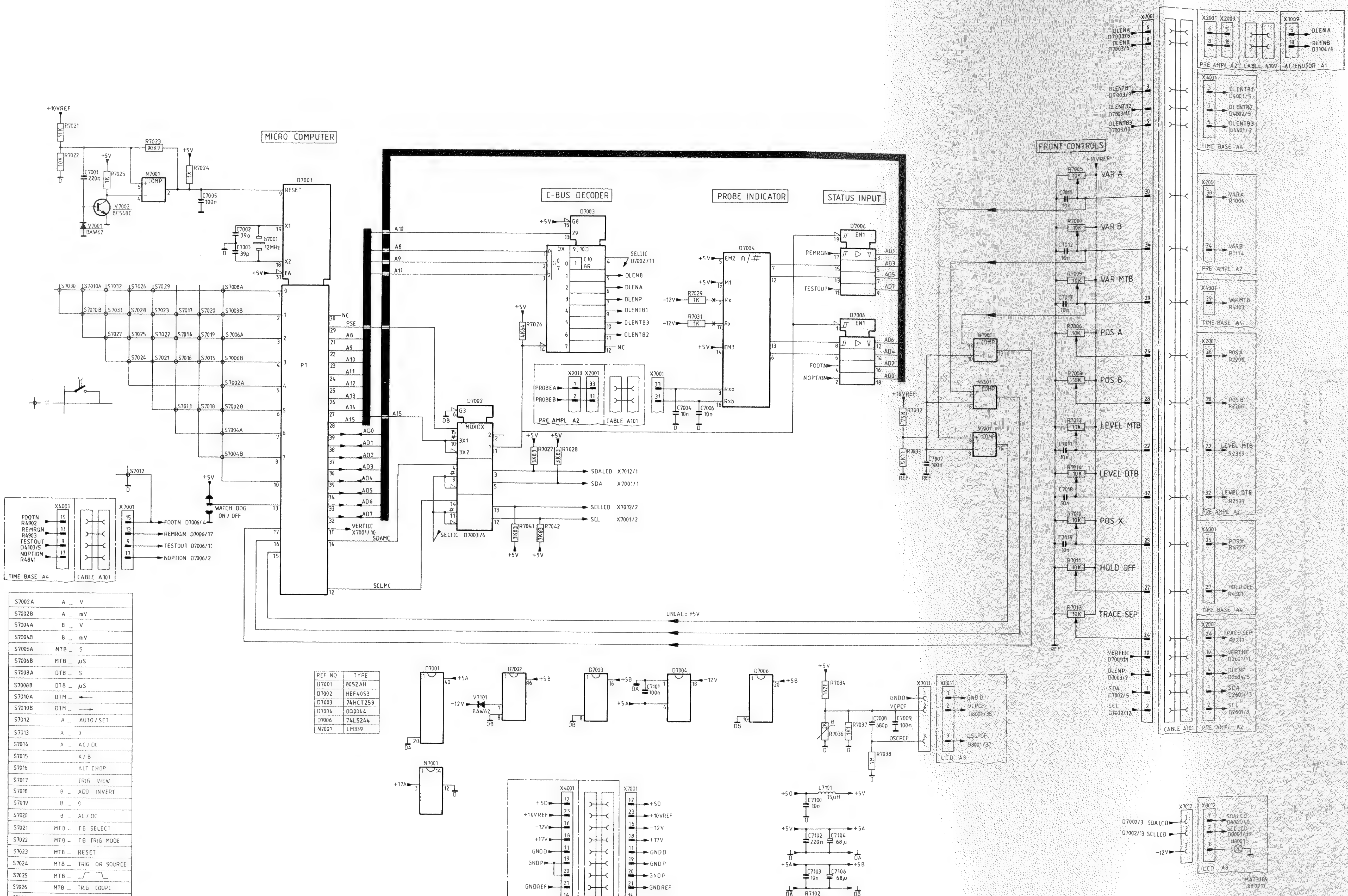


A2
X2004
DELAY-
GND P
DELAY+
X2009
GND A
A-
A+
GND A
DLEN A
VAR A
-12V
+12P
+5A
+10VREF
GND REF
GND P
EXT+
EXT-
GND D
-17V
SDA
DLEN B
SCL
-6.4V
+17V
VAR B
GND B
B+
B-
A104
A101
A102
A110
A109
Y OUT
TIME BASE A4
X4001
SDA
DLEN TB1
DLEN TB3
DLEN TB2
TEST OUT
GND D
REM RQN
FOOT N
N OPTION
GND P
GND REF
+10VREF
POS X
HOLD OFF
VAR MTB
TO X4016/1
TO X4016/9
TO X4016/7
SCL
VERT IIC
+5D
GND D
-12V
+17V
X4002
+12 P
+12 T
LINE
GND P
X
GND T
Z
+10VREF
GND REF
GND D
-17V
+5A
-6.4V
GND T
X -
GND P
INTENS
+17V
-12V
+5D
X4010
TRIGM -
GND T
TRIGD -
XDEFL +
GND T
TBS
CHOP BLN
GND P
LINE
+12P
TRIG M
TRIG D
GND T
XDEFL
ALT CLN
GNDCHOPBLN
-6.4V
+5A
-17V
FROM X4001/1
FROM X4001/15
FROM X4001/13
SDA
+5D
SCL
GND D
GND D
+5D
FOOT N
GND D
REM RQN
+5D
ZMOD
GND T
X4016
X4017
A116
A117
X16
REMOTE CONTROL PLUG
X17
Z-MOD
X8011
GND D
VC PCF
OSL PCF
LCD A8
X8012
SDA LCD
SCL LCD
-12V
ATTENUATOR A1
X1025
X1067
X7
X5
B
FRONT A7
X7011
GND D
VC PCF
OSC PCF
X7001
SDA
DLEN TB1
DLEN TB3
DLEN TB2
TEST OUT
GND D
REM RQN
FOOT N
NOPTION
GND P
GND REF
+10VREF
POS X
HOLD OFF
VAR MTB
PROBE B
PROBE A
SCL
DLEN P
DLEN A
DLEN B
VERT IIC
+5D
GND D
-12V
+17V
GND P
LEVEL MTB
TRACE SEP
POS A
POS B
VAR A
LEVEL DTB
VAR B
X7012
SDA LCD
SCL LCD
MAT 2251A
871218



REF NO	TYPE
N6001	LM358
N6002	LM358
D6501	HEF4066

Figure 9.5 Circuit diagram of power supply



S7002A	A _	V
S7002B	A _	mV
S7004A	B _	V
S7004B	B _	mV
S7006A	MTB _	S
S7006B	MTB _	μS
S7008A	DTB _	S
S7008B	DTB _	μS
S7010A	DTM _	←——
S7010B	DTM _	——→
S7012	A _	AUTO / SET
S7013	A _	0
S7014	A _	AC / DC
S7015		A / B
S7016		ALT CHOP
S7017		TRIG VIEW
S7018	B _	ADD INVERT
S7019	B _	0
S7020	B _	AC / DC
S7021	MTB _	TB SELECT
S7022	MTB _	TB TRIG MODE
S7023	MTB _	RESET
S7024	MTB _	TRIG OR SOURCE
S7025	MTB _	_/‾ ‾_
S7026	MTB _	TRIG COUPL
S7027	DTB _	DTB TRIG
S7028	DTB _	_/‾ ‾_
S7029		XDEFL
S7030		MENU
S7031		EXT AC / DC
S7032		TB MAGN

REF NO	TYPE
D7001	8052AH
D7002	HEF4053
D7003	74HCT259
D7004	OQ0044
D7006	74LS244
N7001	LM339

Figure 10.6 Circuit diagram of front unit

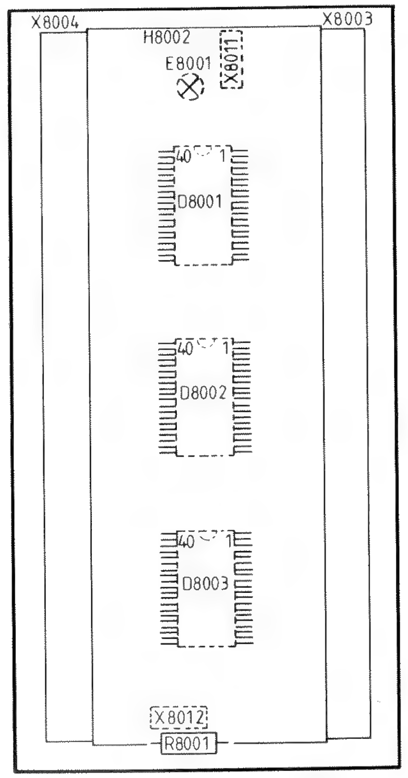
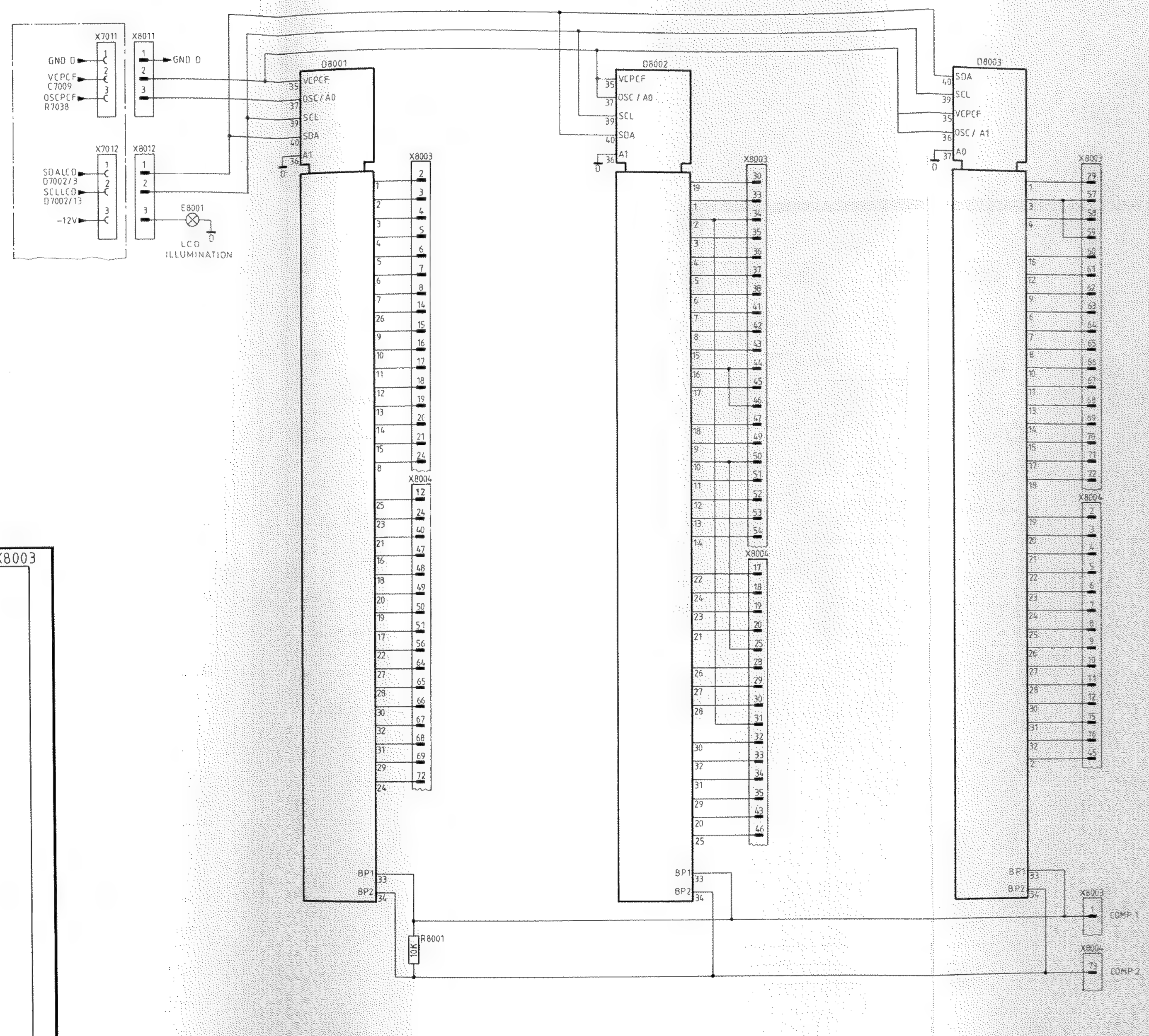
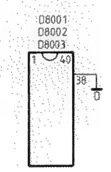


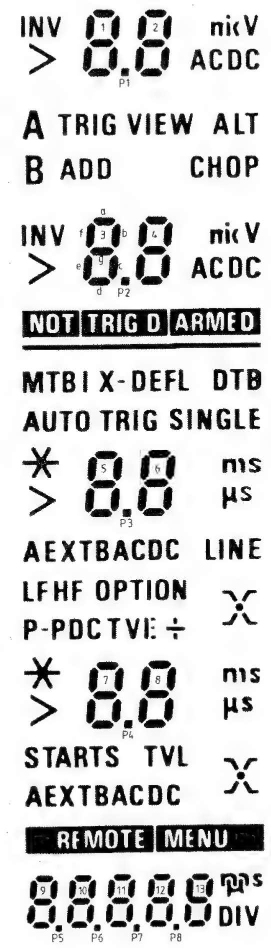
Figure 10.7 LCD unit p.c.b.



REF NO	TYPE
D8001	PCF8577
D8002	PCF8577
D8003	PCF8577



X8004				
	COM1		COM2	
PIN	DISPLAY/SEGMENT	CH	DISPLAY/SEGMENT	CH
73			COM2	
72	>	A	INV	
71	NC		NC	
70	NC		NC	
69	1 a	A	1 f	A
68	1 g	A	1 e	A
67	1 c	A	1 d	A
66	1 b	A	P1	A
65	TRIG VIEW		A	
64	ADD		B	
63	NC		NC	
62	NC		NC	
61	NC		NC	
60	NC		NC	
59	NC		NC	
58	NC		NC	
57	NC		NC	
56	>	B	INV	B
55	NC		NC	
54	NC		NC	
53	NC		NC	
52	NC		NC	
51	3 a	B	3 f	B
50	3 g	B	3 e	B
49	3 c	B	3 d	B
48	3 b	B	P2	B
47	TRIG'D		NOT	
46	XDEFL		TB	
45			M	
44	NC		NC	
43	TRIG		AUTO	
42	NC		NC	
41	NC		NC	
40			>	MTB
39	NC		NC	
38	NC		NC	
37	NC		NC	
36	NC		NC	
35	5 a	MTB	5 f	MTB
34	5 g	MTB	5 e	MTB
33	5 c	MTB	5 d	MTB
32	5 b	MTB	P3	MTB
31		MTB	EXT	MTB
30	B	MTB	A	MTB
29	HF		LF	
28	DC		P-P	
27	NC			
26	NC			
25			*	DTB
24			>	DTB
23	NC		NC	
22	NC		NC	
21	NC		NC	
20	7 a	DTB	7 f	DTB
19	7 g	DTB	7 e	DTB
18	7 c	DTB	7 d	DTB
17	7 b	DTB	P4	DTB
16	B	DTB	STARTS	
15	EXT	DTB	A	DTB
14	DC	DTB	AC	DTB
13	NC		NC	DTM
12	MENU		REMOTE	
11	9 a	DTM	9 f	DTM
10	9 g	DTM	9 e	DTM
9	9 c	DTM	9 d	DTM
8	9 b	DTM	P5	DTM
7	10 a	DTM	10 f	DTM
6	10 g	DTM	10 e	DTM
5	10 c	DTM	10 d	DTM
4	10 b	DTM	P6	DTM
3	11 a	DTM	11 f	DTM
2	11 g	DTM	11 e	DTM
1	NC		NC	



X8003				
	COM1		COM2	
PIN	DISPLAY / SEGMENT	CH	DISPLAY / SEGMENT	CH
1	COM1			
2	2 a	A	2 f	A
3	2 b	A		
4	2 g	A	2 e	A
5	2 c	A	2 d	A
6	m	A	7	A
7	V	A	'<	A
8	DC	A	A	A
9	NC		NC	
10	NC		NC	
11	NC		NC	
12	NC		NC	
13	NC		NC	
14	CHOP		ALT	
15	4 a	B	4 f	B
16	4 b	B		
17	4 g	B	4 e	B
18	4 c	B	4 d	B
19	m	B	7	B
20	V	B	'<	B
21	DC	B	AC	B
22	NC		NC	
23	NC		NC	
24	ARMED		—	
25	NC		NC	
26	NC		NC	
27	NC		NC	
28	NC		NC	
29	DTB		I	
30	SINGLE		*	MTB
31	NC		NC	
32	NC		NC	
33	6 a	MTB	6 f	MTB
34	6 b	MTB		MTB
35	6 g	MTB	6 e	MTB
36	6 c	MTB	6 d	MTB
37	7	MTB	n	MTB
38	s	MTB	μs	MTB
39	NC		NC	
40	NC		NC	
41	DC	MTB	AC	MTB
42	OPTION	MTB	TVI	MTB
43	LINE	MTB	=	MTB
44		MTB		MTB
45		MTB	•	MTB
46		MTB		MTB
47		MTB		MTB
48	NC		NC	
49	8 a	DTB	8 f	DTB
50	8 b	DTB		
51	8 g	DTB	8 e	DTB
52	8 c	DTB	8 d	DTB
53	7	DTB	n	DTB
54	s	DTB	μs	DTB
55	NC		NC	
56	NC		NC	
57		DTB	TVL	DTB
58		DTB	•	DTB
59		DTB		DTB
60	12 a	DTM	12 f	DTM
61	13 a	DTM	13 f	DTM
62	13	DTM		DTM
63	7	DTM	n	DTM
64	s	DTM	μ	DTM
65	V	DTM	DI	DTM
66	13 c	DTM	13 d	DTM
67	13 g	DTM	13 e	DTM
68	12 b	DTM	P8	DTM
69	12 c	DTM	12 d	DTM
70	12 g	DTM	12 e	DTM
71	11 b	DTM	P7	DTM
72	11 c	DTM	11 d	DTM
73	NC		NC	

MAT 2277

Figure 10.8 Circuit diagram of LCD unit

10. FRONT UNIT (A7-A8)

The front unit consists of:

- the microcomputer control circuit
- the LCD display circuit
- the front panel controls

10.1 MICROCOMPUTER CONTROL CIRCUIT

10.1.1 Introduction to MAB8052 microcomputer

The integrated circuit MAB8052, one of the MSC-51 family of single chip microcomputers, forms the basis of the microcomputer system of the oscilloscope. The MAB8052 has an internal 8 k ROM and 256 bytes RAM with address/data decoding facilities. In addition to this, the 8052 has 32 I/0 lines. Data written to these lines remains unchanged until rewritten. Each line is able to serve as input or output, or both, even though outputs are statically latched. To provide specific serial data transfer possibilities, the microcomputer system contains an I^2C bus interface.

10.1.2 Characteristics of the I^2C bus

The I^2C bus is for 2-way, 3-line communication between different ICs or modules. The three lines are a serial data line (SDA), a serial clock line (SCL) and ground. Both lines must be connected to a positive supply via a pull-up resistor when connected to the output stages of a device. Data transfer may be initiated only when the bus is not busy.

Bit transfer:

One data bit is transferred during each clock pulse. The data on the SDA line must remain stable during the HIGH period of the clock pulse as changes in the data line at this time will be interpreted as control signals.

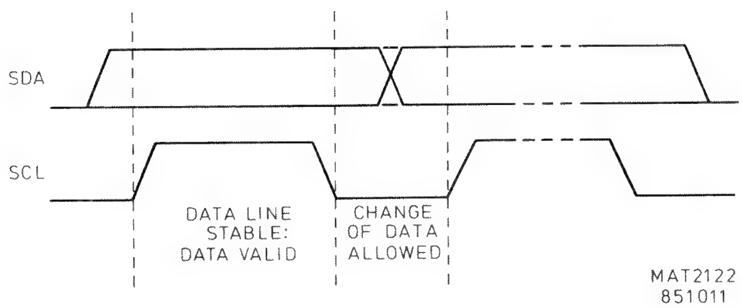


Figure 10.1 Bit transfer

Start and stop conditions:

Both data and clock lines remain HIGH when the bus is not busy. A HIGH-to-LOW transition of the data line, while the clock is HIGH is defined as the start condition (S). A LOW-to-HIGH transition of the data line while the clock is HIGH is defined as the stop condition (P).

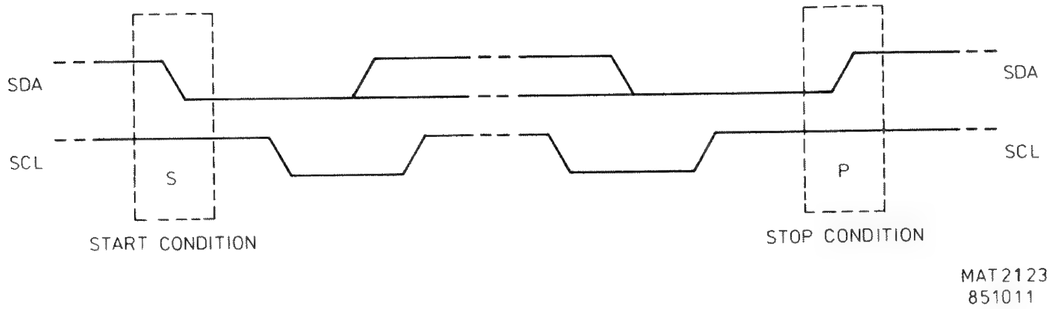


Figure 10.2 Definition of start and stop conditions

10.1.3 I^{2}C structure

The two lines SDA and SCL are fed to the various circuits, where, depending on the addressing, this serial information is converted into the different control signals (see figure 10.3).

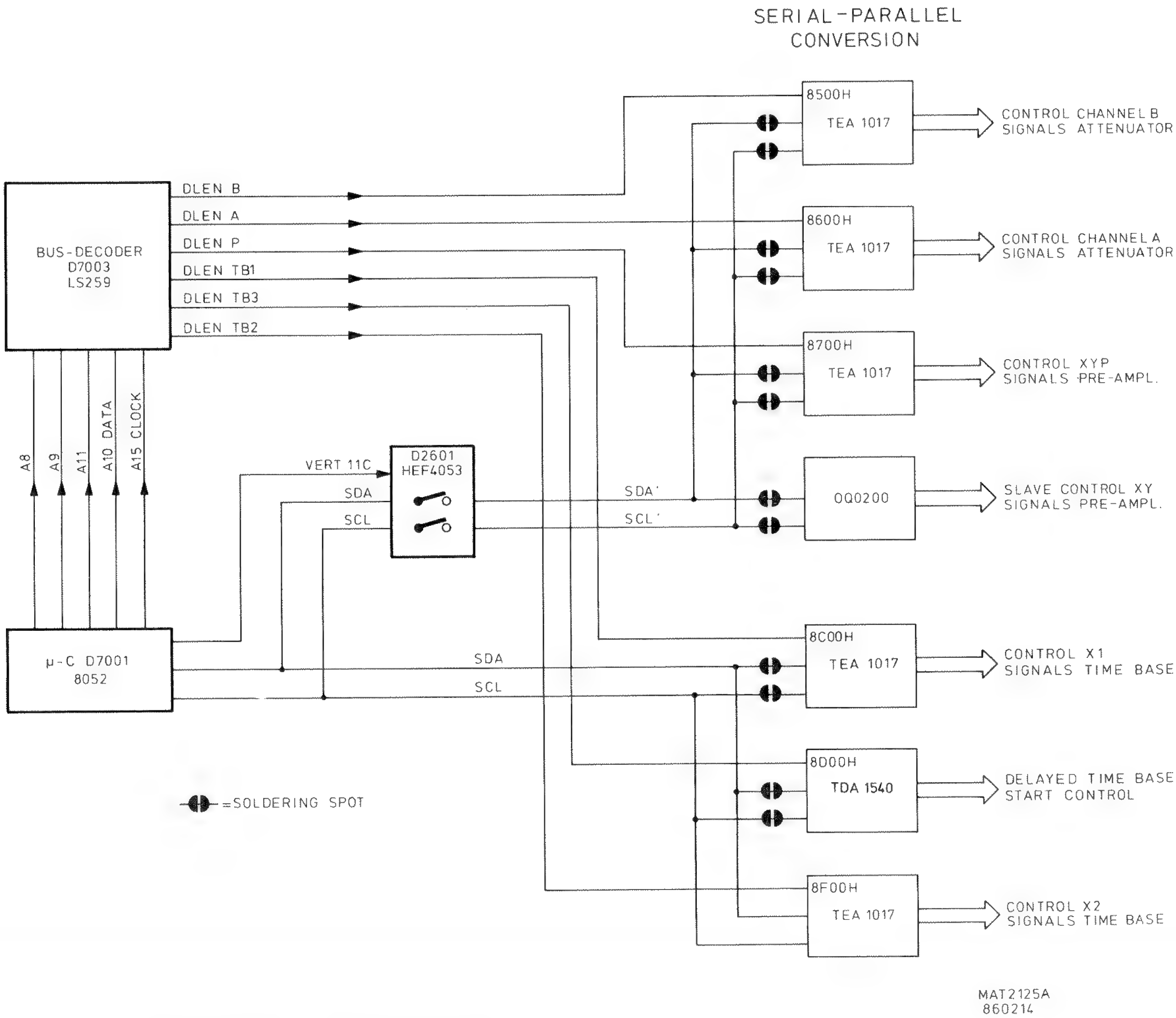


Figure 10.3 I^{2}C structure

To select the serial-parallel conversion circuits, the bus decoder D7003 decodes the address lines A8, A9 and A11 into the DLEN (Data latch enable) signals according to the next table

ADDRESS LINES A11	A9	A8	DATA A10		
0	0	0	1/0	8400H	SEL IIC
0	0	1	1/0	8500H	DLEN B
0	1	0	1/0	8600H	DLEN A
0	1	1	1/0	8700H	DLEN P
1	0	0	1/0	8C00H	DLEN TB1
1	0	1	1/0	8D00H	DLEN TB3
1	1	0	1/0	8E00H	DLEN TB2
1	1	1	1/0	8F00H	N.C.

To eliminate interference in the vertical circuits, the I^2C bus can be switched off for this circuit by switch D2601. The timing is obtained by the VERT IIC line.
Note that for servicing, solder joints are added in the p.c.b. tracks connecting the circuits. These can be used to localize a fault in the I^2C-bus by means of interrupting the bus connection.

10.1.4. Microcomputer MAB8052

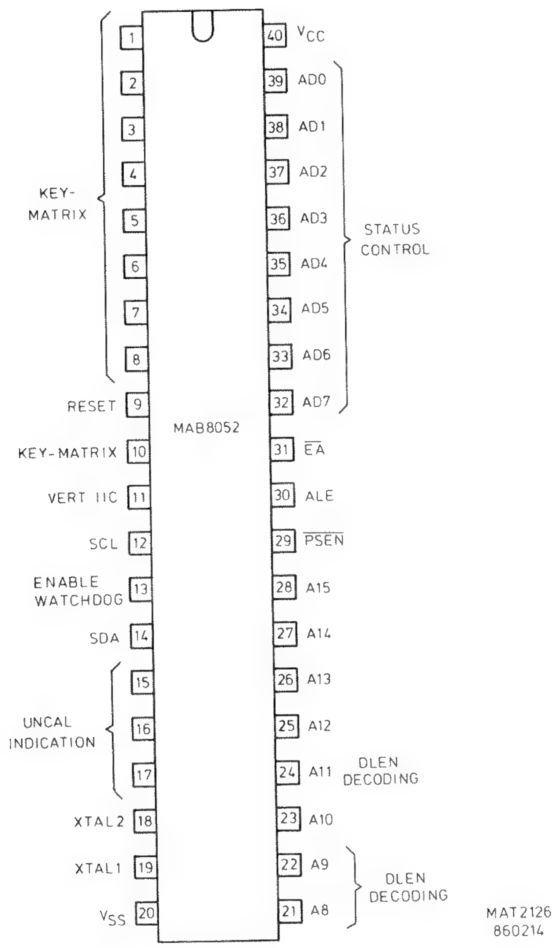


Figure 10.4 Pinning of microcomputer MAB 8052

The microprocessor has the following connections:

* Crystal connections (pin 18 and 19)
  A 12 MHz crystal is connected to the inputs XTAL1 and XTAL2 to provide an accurate timing reference source.

* RESET input (pin 9)
  After switching on a reset level HIGH is applied to this input. This reset signal forces the microcomputer to initiate the main program, beginning at the address 00000H. After the +5 V supply is within its specification, the RESET is released and the microcomputer is ready for use.

* 8-bit quasi bidirectional I/O port (pin 1...pin 8) and quasi-bidirectional I/O port (pin 10), used to read the settings of the KEY-MATRIX switches S2...S32 (excl. S12-AUTOSET)

* 3-bit quasi-bidirectional I/O port (pin 15...pin 17), used to read the UNCAL position of S5, S7 and S9 (UNCAL when logic HIGH).

* WATCHDOG input (pin 13)
  The WATCHDOG is a facility to control the correct function of the software. When HIGH the internal counter will run. The software gives a pulse every 64 ms max. to reset this counter, so that the 64 ms max. cycle starts again. If the software does not function correctly, the internal counter receives no reset pulse and the counter will overflow initiating the main program (start address 0000H).

* 8-bit open drain bidirectional I/O port (pin 21...pin 28) used for addressing the serial-parallel conversion circuits (see I^2C structure).

* 8-bit quasi-bidirectional I/O port (pin 32...pin 39) used to read the status input via D7006.

* SDA (pin 14); SCL (pin 12)
  Bidirectional I^2C lines.

* VERT IIC (pin 11)
  Signal used as a digital switch control to switch-off the I^2C bus of the pre-amplifier control.

10.1.5. I^2C decoding

Integrated circuit D7002 serves as a multiplexer to make a separation between the I^2C lines for the LCD drives and the I^2C lines for the other circuits, controlled by the SEL IIC line. Only when SEL IIC is HIGH (address 8400H), are the SDA and SCL lines from the microcomputer connected to unit A8.

10.1.6. Status input

Integrated circuit D7006 serves as an input port to read the following status info:

- TEST OUT, indication for triggered mode, HIGH when triggered.
- FOOTN, remote control for AUTO SET, LOW when active.
- NOPTION, adapts software for optional trigger coupling, LOW when optional triggering.
- REMRQN, remote request line, LOW when active.
- probe indication status, adapts V/DIV reading for probe attenuation.

When the enable inputs (pin 1 and pin 19) become LOW, the status input is read and copied in the accumulator of the microcomputer via the data lines AD0...AD7.

Note that enabling is only possible when D7002-2 is switched-on to D7002-15, i.e. when A15 is HIGH (address 8000H ... FFFFH).

10.1.7 Probe indicator

Integrated circuit D7004 (000044) detects the kind of probe which is connected to the oscilloscope. Depending on the resistance between the probe indication input (pin 3 for channel A and pin 16 for channel B) and ground, the V/DIV reading of the LCD automatically increases according to the next table.

Pin 3 (16)	Pin 6 (17)	Pin 7 (12)	V/DIV attenuation
2k32	0	0	x10
6k98	1	0	x100
7k68	0	1	x1
10k	1	1	x1

10.1.8 C-Bus decoder

This integrated circuit decodes the address lines A8, A9 and A11 into the DLEN signals.
During the power-up all the lines are reset to LOW.

10.2 LCD DISPLAY CIRCUIT

The LCD is driven by three drivers D8001, D8002 and D8003 (PCF8577).
The temperature dependent supply voltage VCPCF is 4 V approx. at 25^{o}C. When the temperature increases, this voltage decreases.
The single-pin built-in oscillator on pin 37 of D8001 provides the modulation frequency for the LCD segment driver outputs. Capacitor C7008 and resistor R7038 are connected to this pin to form the oscillator, with a frequency of 150 Hz approx. Pin 36 and pin 37 are used to determine the LCD drivers address in the I^2C bus.

The outputs pin 1...pin 32 directly drive the LCD.

Outputs BP1 and BP2 (pin 33 and pin 34) drive the COMMON pins of the LCD.

10.3 FRONT-PANEL CONTROLS

The front-panel controls give a voltage between 0 V...10 V to the various circuits.
To determine the UNCAL condition of VAR A, VAR B or VAR MTB, the d.c. voltages of the slider of the potentiometers are applied to comparator N7001. When the voltage level of the control is lower than 0,7 V, the microcomputer reads a logic LOW on its input and adapts the LCD display to indicate the CAL status (e.g. no flashing ">" sign visible).

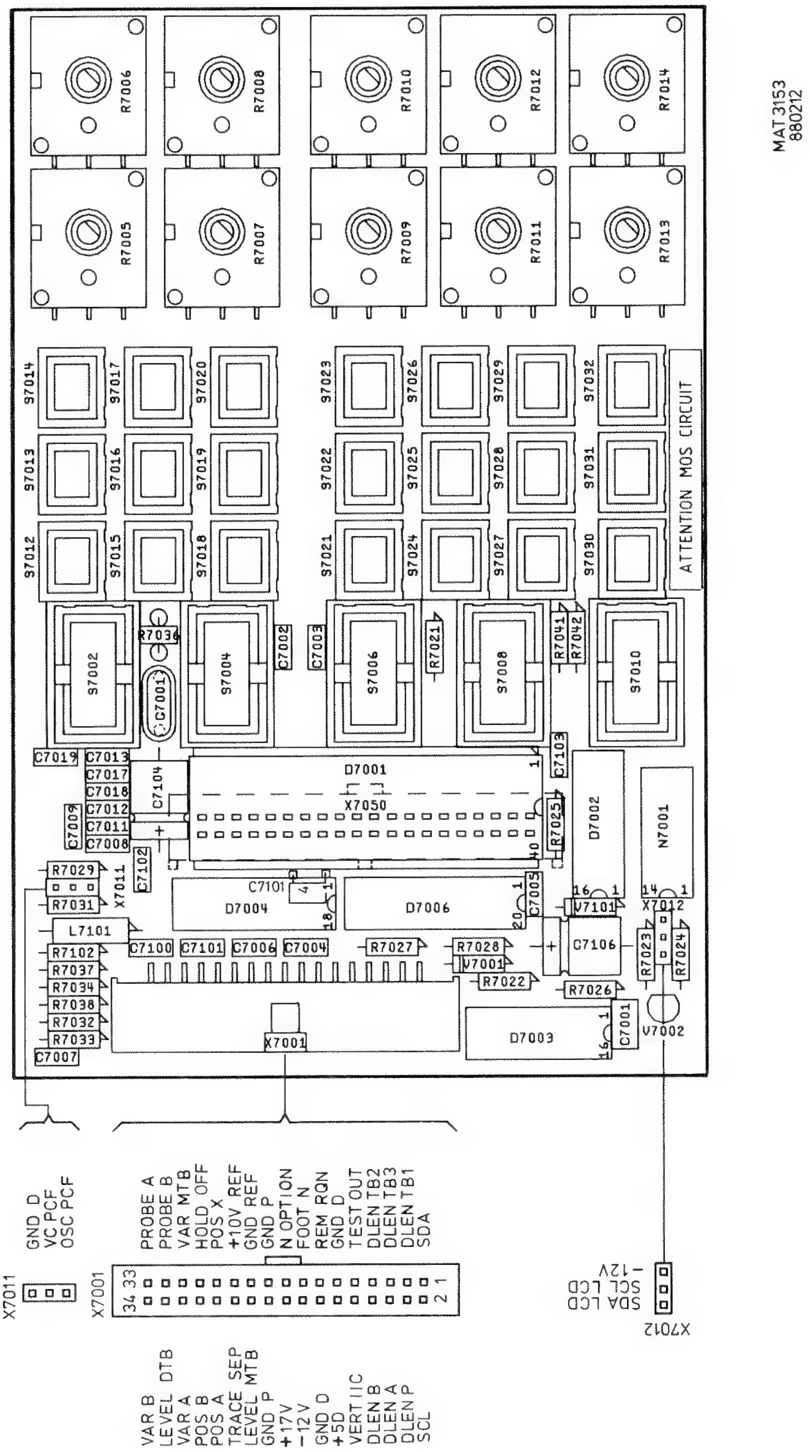


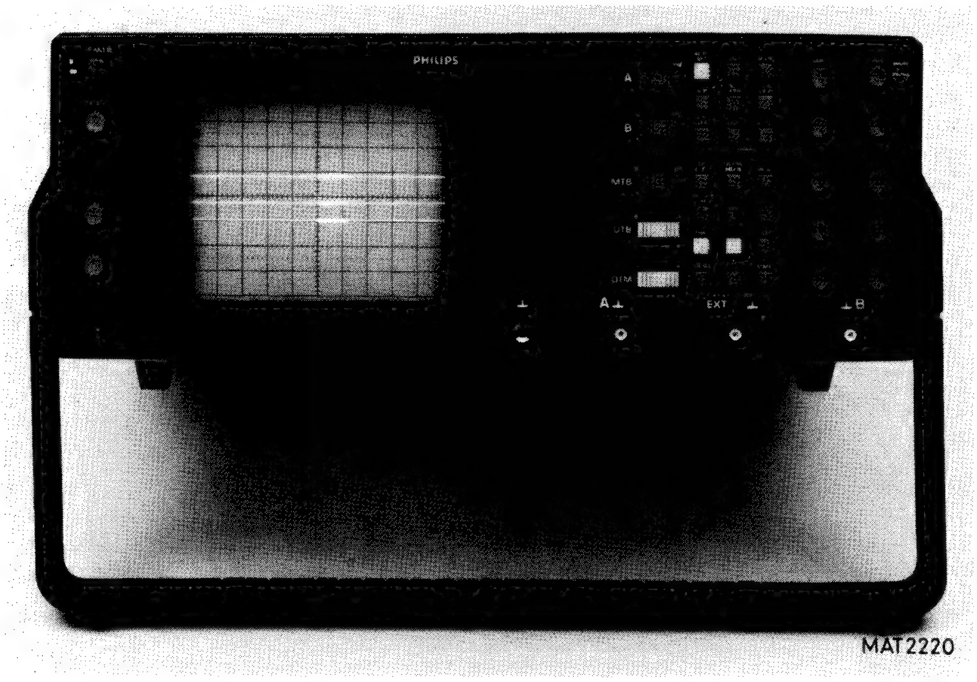
Figure 10.5 Front unit p.c.b.

60 MHz Dual Time Base Oscilloscope

PM3055

Service Manual

4822 872 05327
880411/2



WARNING: These servicing instructions are for use by qualified personnel only. To reduce the risk of electric shock do not perform any servicing other then that specified in the Operating Instructions unless you are fully qualified to do so.

PHILIPS

IMPORTANT: In correspondence concerning this instrument, please quote the type number and serial number as given on the type plate.

NOTE: The design of this instrument is subject to continuous development and improvement. Consequently, this instrument may incorporate minor changes in detail from the information contained in this manual.

CONTENTS Page

LIST OF FIGURES

1. SAFETY INSTRUCTIONS

Read these pages carefully before installation and use of the instrument.

1.1 INTRODUCTION

The following clauses contain information, cautions and warnings which must be followed to ensure safe operation and to retain the instrument in a safe condition.
Adjustment, maintenance and repair of the instrument shall be carried out only by qualified personnel.

1.2 SAFETY PRECAUTIONS

For the correct and safe use of this instrument it is essential that both operating and servicing personnel follow generally-accepted safety procedures in addition to the safety precautions specified in this manual.
Specific warning and caution statements, where they apply, will be found throughout the manual.
Where necessary, the warning and caution statements and/or symbols are marked on the apparatus.

1.3 CAUTION AND WARNING STATEMENTS

CAUTION: is used to indicate correct operating or maintentance procedures in order to prevent damage to or destruction of the equipment or other property.

WARNING: calls attention to a potential danger that requires correct procedures or pracites in order to prevent personal injury.

1.4 SYMBOLS

	High voltage $\geq$ 1000 V	(red)
	Live part	(black/yellow)
	Read the operating instructions	
	Protective earth (grounding) terminal	(black)

1.5 IMPAIRED SAFETY-PROTECTION

Whenever it is likely that safety-protection has been impaired, the instrument must be made inoperative and be secured against any unintended operation. The matter should then be referred to qualified technicians.
Safety protection is likely to be impaired if, for example, the instrument fails to perform the intended measurements or shows visible damage.

1.6 GENERAL CLAUSES

1.6.1 WARNING: The opening of covers or removal of parts, except those to which access can be gained by hand, is likely to expose live parts and accessible terminals which can be dangerous to live.

1.6.2 The instrument shall be disconnected from all voltage sources before it is opened.

1.6.3 Bear in mind that capacitors inside the instrument can hold their charge even if the instrument has been separated from all voltage sources.

1.6.4 WARNING: Any interruption of the protective earth conductor inside or outside the instrument, or disconnection of the protective earth terminal, is likely to make the instrument dangerous. Intentional interruption is prohibited.

1.6.5 Components which are important for the safety of the instrument may only be renewed by components obtained through your local Philips organisation. (See also section 15).

1.6.6 After repair and maintenance in the primary circuit, safety inspection and tests, as mentioned in section 15 have to be performed.

2. CHARACTERISTICS

A. Performance Characteristics

- Properties expressed in numerical values with stated tolerance are guaranteed by PHILIPS Specified non-tolerance numerical values indicate those that could be nominally expected from the mean of a range of identical instruments.
- This specification is valid after the instrument has warmed up for 30 minutes (reference temperature 23°C).
- For definitions of terms, reference is made to IEC Publication 351-1.

B. Safety Characteristics

- This apparatus has been designed and tested in accordance with Safety Class I requirements of IEC Publication 348, Safety requirements for Electronic Measuring Apparatus, UL 1244 and CSA 556B and has been supplied in a safe condition.

C. Initial Characteristics

. Overall dimensions:

- Width

Including handle	: 387 mm
Excluding handle	: 350 mm

- Length

Including handle, excl. knobs	: 518,5 mm
Excluding handle, excl. knobs	: 443,5 mm
Including handle, incl. knobs	: 530,5 mm
Excluding handle, incl. knobs	: 455,5 mm

- Height

Including feet	: 146,5 mm
Excluding feet	: 134,5 mm
Excl. under cabinet	: 132,5 mm

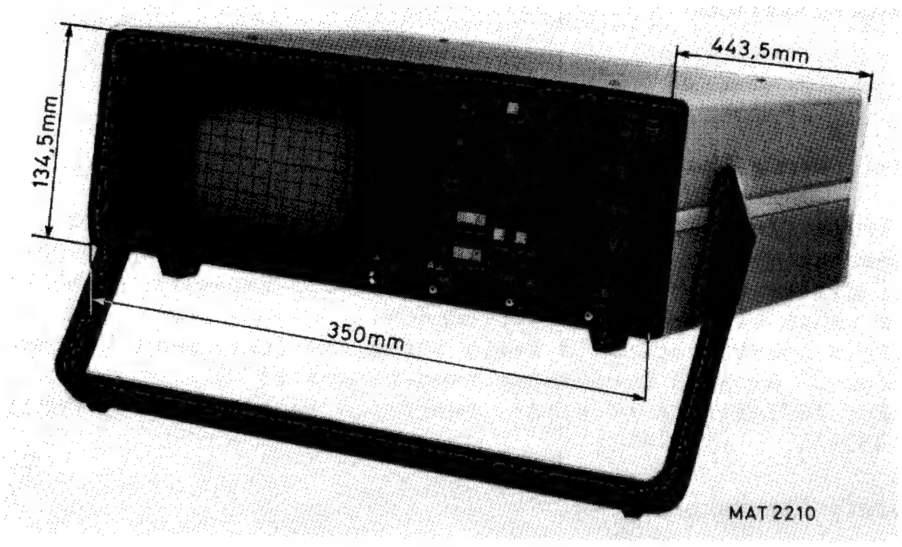


Figure 2.1 Dimensions

* Mass : 7,5 kg

* Operating positions:

  a. Horizontally on bottom feet
  b. Vertically on rear feet
  c. On the carrying handle in two sloping positions.

D. CONTENTS

2.1. Display
2.2. Vertical deflection or Y axis
2.3. Horizontal deflection or X axis
2.4. Triggering
2.5. Power Supply
2.6. Auxiliary inputs or outputs
2.7. Environmental characteristics
2.8. Safety

CHARACTERISTICS	SPECIFICATION	ADDITIONAL INFORMATION
2.1 DISPLAY		
* CRT		
Type No	PHILIPS D 14-372	
Measuring area (h x w)	80 x 100 mm	8 x 10 div. 1 div. = 10 mm 1 subdiv. (sd) = 2 mm
* Screen type		
Standard	GH (P 31)	
Option	GM (P 7)	Long persistence
* Total acceleration voltage	16 kV	
* Graticule		
Engravings	Internal fixed	
Division lines	1 cm	Horizontal as well as vertical
Subdivisions	2 mm	Idem.
Dotted lines	1,5 and 6,5 cm from top	Only horizontal.
Percentages	0%, 10%, 90%, 100%	
* Orthogonality	90^{o} +/- 1^{o}	Measured in zero point.
* Illumination	Continuously variable	
* Display time per channel in chopped mode	< 2 us	
* LCD liquid crystal display		All relevant settings are visible in display.
Type No	LC 9438130	
Visible area	25,4 x 88,8 mm	
Back lighting	Permanently on	
2.2 VERTICAL DEFLECTION OR Y AXIS		
2.2.1 Channels A and B		
* Deflection coeff.	2 mV/div...10 V/div	In 1, 2, 5 sequence. If PM 8936/09 is used, deflection coeff. is automatically calculated in display.
* Variable gain control range	1 : >2,5	
* Error limit	< +/- 3%	Only in calibrated position.
* Input impedance	1 M ohm +/-2%	Measured at f_o < 1 MHz
Paralleled by	20 pF +/-2pF	Measured at f_o < 1 MHz

CHARACTERISTICS	SPECIFICATION	ADDITIONAL INFORMATION
* Max. input voltage	400 V (d.c. + a.c. peak)	
Max. test voltages (rms)	500 V	Max. duration 60 sec.
* Bandwidth for 20 mV...10 V	> 60 MHz (amb.: 0...35°C)	Input 6 div. sine-wave.
Bandwidth for 2 mV, 5 mV and 10 mV	> 35 MHz	Input 6 div. sine-wave.
* Rise-time	5,8 ns or less	Calculated from 0,35/f-3 dB
* Noise		
20 mV...10 V	< 0,5 sd	Measured visually. Pick up on open BNC excluded.
* Lower - 3 dB point	< 10 Hz	In AC position, 6 div. sine-wave
* Dynamic range		
@ 1 MHz	> +/- 12 div.	Vernier in cal. position.
@ 50 MHz	> 8 div.	Vernier in cal. position.
* Position range	> +/- 8 div.	Vernier in cal. position.
* Decoupling factor between channels		Both channels same attenuator setting. Input max. 8 div. sine-wave.
@ 10 MHz	1 : > 100	2,5 and 10 V are excluded.
@ 50 MHz	1 : > 50	2,5 and 10 V are excluded.
* Common Mode Rejection Ratio @ 1 MHz	1 : > 100	Both channels same attenuator setting, vernier adjusted for best CMRR; measured with max. 8 div. (+/- 4 div.) each channel.
* L.F.Non Linearity	< 3%	
* Visible signal delay	> 15 ns	Max. intensity, measured from line start to trigger point

CHARACTERISTICS	SPECIFICATION	ADDITIONAL INFORMATION
* Base-line jump between attenuator steps 20 mV...10 V	< 1 sd	
Additional jump between 10 mV <---> 20 mV	< 1,5 sd	
Normal Invert jump	< 1 sd	Only channel B.
ADD jump	< 0,6 div.	When A and B are positioned in screen centre (20 mV...10 V).
Variable jump	< 1 sd	Max.jump in any position of the vernier.

2.2.2 Triggerview

* Bandwidth via A or B channel 2 mV, 5 mV, 10 mV	> 35 MHz	6 div. sine-wave
20 mV...10 V	> 50 MHz (Amb.: 0...35°C)	
Via EXT. input	> 50 MHz	6 div. sine-wave (+/- 3 div. from screen centre).
* Deflection coeff. Via channel A or B	2 mV/div...10 V/div	1, 2, 5 sequence (see Channel A, B).
Via EXT. input	100 mV/div.	
Error limit	< 5%	INTERNAL, EXTERNAL.
* Lower - 3 dB point AC coupling EXT. input	< 10 Hz	Only when trigger coupling is DC.
* Line jump trigger source	< 2 sd	Jump between trigger source A, B composite and EXT.
* OFFSET trig.point from screen centre	< 1,5 sd	
* Delay EXT. trigger view and channel A or B	< 10 ns	
* Dynamic range EXT. input		
@ 1 MHz	> +/- 12 div.	
@ 50 MHz	> 6 div.	

	CHARACTERISTICS	SPECIFICATION	ADDITIONAL INFORMATION
2.3	HORIZONTAL DEFLECTION OR X AXIS		
	* Horizontal display modes	MTB, MTBI, ALT.TB, DTB X-DEFL	
2.3.1	Main Time Base (MTB)		
	* Time coeff.	0,5 sec...50 ns	1, 2, 5 sequence (magn.off)
	Error limit	< 3%	Measured at -4...+4 div. from screen centre.
	* Horizontal position range	Start of sweep and 10th div. must be shifted over screen centre	
	* Variable control ratio	1 : > 2,5	
	* Time Base magnifier	Expansion *10	Not valid in X-deflection.
	Error limit	< 4%	Measured at +4...-4 div. from screen centre. Excluding first 50 ns and last 50 ns.
	* Horizontal magnifier balance * 10 ---> * 1	< 2,5 sd	Shift start of sweep in * 10 in mid-screen position, then switch to * 1.
	* Hold-Off Minimum to maximum hold-off time ratio	1 : > 10	Minimum hold off time is related to time base setting.
2.3.2	Delay Time Base (DTB)		
	* Time coeff.	1 ms...50 ns	Sequence 1, 2, 5.
	Error limit		See MTB
	* Horizontal position range		See MTB
	* Time Base Magnifier		See MTB

CHARACTERISTICS	SPECIFICATION	ADDITIONAL INFORMATION
* Delay time Multiplier Error limit	3% + 1% incremental delay error + 25 ns +/- 5 ns	* 1 only
Incremental delay time error	< 1%	* 1 only
* Resolution	1 : 10 000	
* Delay Time Jitter	1 : > 20 000	
* Trace separation		Only valid in alternate time base.
Shift range	> +/- 4 div.	DTB shifts only.

2.3.3 X-deflection

* Deflection coeff.		
Via channel A or B	2 mV/div...10 V/div	1, 2, 5 sequence.
Via EXT. input	100 mV/div.	
* Error limit		
Via channel A or B	< +/- 5%	
Via EXT. input	< +/- 5%	
* Bandwidth	DC .... > 2 MHz	DC coupled
* Phase shift between X and Y-deflection	< 3^{o} @ 100 kHz	
* Dynamic range	> +/- 12 div. @ 100 kHz	

2.3.4 EXT input

* Input impedance	1 M ohm +/- 2%	f_o < 1 MHz
Paralleled by	20 pF +/- 2 pF	f_o < 1 MHz
* Max. input voltage	400 V (d.c. + a.c. peak)	
Max. test voltage (rms)	500 V	Max. duration 60 sec.
* Lower - 3 dB point	< 10 Hz	AC coupled

CHARACTERISTICS	SPECIFICATION	ADDITIONAL INFORMATION
2.4 TRIGGERING		
2.4.1 MTB triggering		
* Trig.mode		
AUTO (auto free run)	Bright line in absence of trigger signal	Auto free run starts 100 ms (typ.) after no trig.pulse.
Triggered		Switches automatically to auto free run if one of the display channels is grounded.
Single		In multi-channel mode (alternated) each channel is armed after reset; if sweep has already started, sweep is not finished. Not applicable in peak to peak coupling.
* Trigger source A, B, Composite (AB), EXT, Line		Line trigger source always triggers on main frequency. Line trigger amplitude depends on line input voltage. Approx. 6 div. @ 220 VAC input voltage.
* Trigger coupling Peak-to-peak (p-p), DC, TVL, TVF		
* Level range		
Peak-to-peak	Related to peak-to-peak	p-p coupling is DC rejected.
DC INTERNAL	> (+ or - 8 div.)	
DC EXTERNAL	> (+ or - 800 mV)	
TVL/TVF	Fixed level	
* Trigger slope	+/-	Slope sign in LCD and + or - if TVL/F in chosen for positive or negative video.
* Trigger sensitivity		
INTERNAL		
0 - 10 MHz	< 0,5 div.	Trig. coupling DC.
@ 50 MHz	< 1,0 div.	Trig. coupling DC.
@ 100 MHz	3,0 div.	Trig. coupling DC.
EXTERNAL		
0 - 10 MHz	< 50 mV	Trig. coupling DC.
@ 50 MHz	< 150 mV	Trig. coupling DC.
@ 100 MHz	500 mV	Trig. coupling DC.
TVL/F INTERNAL	< 0,7 div.	Sync. pulse.
EXTERNAL	< 70 mV	Sync. pulse.

	CHARACTERISTICS	SPECIFICATION	ADDITIONAL INFORMATION
2.4.2	DTB Triggering		
	* DTB trigger source Starts, A, B, Composite (AB), EXT and TVL		TVL has same trig.source as MTB trig. source TVL only valid if MTB trig. coupling TVL or TVF is chosen.
	* Coupling	DC	
	* Trigger sensitivity	See MTB	
	* Trigger Level range	> (+ or - 8 div.)	
	* Trigger slope	+/-	Slope sign in LCD, if TVL is chosen. Slope sign is not valid
2.5	POWER SUPPLY		
	* Line input voltage AC		One range.
	Nominal	100 - 240 V	
	Limits of operation	90 - 264 V	
	* Line frequency		
	Nominal	50 - 400 Hz	
	Limits of operation	45 - 440 Hz	
	* Safety requirements within specification of: IEC 348 CLASS I, UL 1244, VDE 0411, CSA 556 B		
	* Power consumption	45 W	

	CHARACTERISTICS	SPECIFICATION	ADDITIONAL INFORMATION
2.6	AUXILIARY INPUTS OR OUTPUTS		
	* Z-MOD		TTL-compatible.
	ViH	> 2,0 V	Blanks display.
	ViL	< 0,8 V	Max. intensity Analogue control between ViH and ViL is possible.
	* DIN plug 9-pin (female)		For IEEE control, front-panel memory back-up.
	* CAL		To calibrate drop or tilt probes.
	Output voltage	1,2 V +/- 1%	Rectangular output pulse.
	Frequency	2 kHz	
	The output may be short-circuit to ground.		

2.7 ENVIRONMENTAL CHARACTERISTICS

The environmental data mentioned in this manual are based on the results of the manufacturer's checking procedures.
Details on these procedures and failure criteria are supplied on request by the PHILIPS organisation in your country, or by PHILIPS, INDUSTRIAL AND ELECTRO-ACOUSTIC SYSTEMS DIVISION, EINDHOVEN, THE NETHERLANDS.

CHARACTERISTICS	SPECIFICATION	ADDITIONAL INFORMATION
* Meets environmental requirements of:	MIL-T-28800 C, type III, CLASS 5 Style D	
* Temperature		
Operation temp. range within specification	10...40°C	MIL-T-28800 C par. 3.9.2.3. tested, par. 4.5.5.1.1.
Limits of operation temperature range	0 ...50°C	Idem.
Non-operating (Storage)	- 40°C/+ 75°C	MIL-T-28800 C par. 3.9.2.3. tested, par. 4.5.5.1.1.
* Max. humidity		
operating non-operating	95% RH	10...30°C
* Max. altitude		MIL-T-28800 C par. 3.9.3. tested, par. 4.5.5.2.
Operating	4,5 km (15000 feet)	Maximum (Operating Temperature derated 3°C for each km, for each 3000 feet, above sea level).
Non-operating (storage)	12 km (40 000 feet)	

CHARACTERISTICS	SPECIFICATION	ADDITIONAL INFORMATION
* Vibration (operating)		MIL-T-28800 C par. 3.9.4.1. tested, par. 4.5.5.3.1.
Freq. 5...15 Hz Sweep Time	7 min.	
Excursion (p-p)	1,5 mm	
Max Acceleration	7 m/s^2 (0,7 x g)	@ 15 Hz
Freq. 15...25 Hz Sweep Time	3 min.	
Excursion (p-p)	1 mm	
Max Acceleration	13 m/s^2 (1,3 x g)	@ 25 Hz
Freq. 25...55 Hz Sweep Time	5 min.	
Excursion (p-p)	0,5 mm	
Max Acceleration	30 m/s^2 (3 x g)	@ 55 Hz
Resonance Dwell	10 min.	@ each resonance freq. (or @ 33 Hz if no resonance was found). Excursion, 9.7.1. to 9.7.2.
* Shock (operating)		MIL-T-28800 C par. 3.9.5.1. tested, par. 4.5.5.4.1.
Amount of shocks		
total	18	
each axis	6	(3 in each direction).
Shock Wave-form	Half sine-wave	
Duration	11 ms	11 ms
Peak Acceleration	300 m/s^2 (30 x g)	
* Bench handling		Mil-T-28800 C par. 3.9.5.3. tested, par. 4.5.5.4.3.
Meets requirements of	MIL-STD-810 method 516, proced. V	
* Salt Atmosphere		MIL-T-28800C par. 3.9.8.1 tested, par. 4.5.6.2.1.
Structural parts meet requirements of	MILT-STD-810 methode 509, proced. I salt solution 20%	
* EMI (Electronic Magnetic Interference) meets requirements of	MIL-STD-461 CLASS B	Applicable requirements of part 7 : CE03, CS01, CS02, CS06, RE02, RS03
	VDE 0871 and VDE 0875 Grenzwertklasse B	

CHARACTERISTICS	SPECIFICATION	ADDITIONAL INFORMATION
* Magnetic Radiated Susceptibility Maximum Deflection Factor		Tested in conformity with IEC 351-1 par. 5.1.3.1. Measured with instrument in a homogeneous magnetic field (in any direction with respect to instrument) with a flux intensity (p-p value) of 1,42 mT (14,2 gauss) and of symmetrical sine-wave form with a frequency of 45...66Hz.

2.8 SAFETY

* Meets requirements of	IEC 348 CLASS I VDE 0411	Except for power cord, unless shipped with Universal European power plug.
	UL 1244 CSA 556 B	Except for power cord, unless shipped with North American power plug.
* Max. X-Radiation		Measured @ 5 cm from surface of instrument for a target area of 10 cm^2
* Recovery time	15 min.	$-10^{o}C$ ----> + $25^{o}C$ ambient temp.
	30 min.	$-20^{o}C$ ----> + $25^{o}C$ ambient temp.
	45 min.	$-30^{o}C$ ----> + $25^{o}C$ ambient temp.
	60 min.	$-40^{o}C$ ----> + $40^{o}C$ ambient temp.

3. INTRODUCTION TO CIRCUIT DESCRIPTION AND BLOCK DIAGRAM DESCRIPTION

3.1 INTRODUCTION TO CIRCUIT DESCRIPTION

The functioning of the circuits is described per printed-circuit board (p.c.b.). For every p.c.b. a separate chapter (4-10) is available containing the lay out of the p.c.b., the associated circuit diagram(s) and the circuit description.

Location of electrical parts

The item numbers of C...., R...., V...., N...., D.... and K.... have been divided into groups which relate to the circuit and the printed-circuit board according to the following table:

Item number	unit no.	Printed-circuit board	Figure
1000-1999	A1	Attenuator unit	4
2000-2999	A2	Pre-amplifier unit	5
3000-3999	A3	XYZ amplifier unit	6
4000-4999	A4	Time-base unit	7
5000-5999	A5	CRT control unit	8
6000-6999	A6	Power supply	9
7000-7999	A7	Front unit	10
8000-8999	A8	LCD unit	10

3.2 BLOCK DIAGRAM DESCRIPTION (see figure 3.1).

3.2.1 Introduction

This block diagram description is based around all the important functional blocks and their interconnections. The interconnections between all p.c.b.'s are given in the interconnection diagram of figure 14.5. In order to assist in cross-reference with the circuit diagrams, the blocks include the item numbers of the active components they contain.
Furthermore, the blocks are grouped together per printed-circuit board or a part of it. To facilitate reference, the names of the functional blocks are given in text in CAPITALS.
Signal waveforms are also indicated at block interconnections where useful.
In this instrument almost all the switches (UP-DOWN controls, softkeys and potentiometer UNCAL switches) influence the oscilloscope circuits via a microcomputer (uC) system.

3.2.2 Control unit

Because the functional description of the control unit (see chapter 1(is almost simular to the blockdiagram description, no specific attention is given in this chapter to this unit.

3.2.3 Attenuator unit

The vertical channels A and B for the signals to be displayed are identical. Each channel comprises an input SIGNAL COUPLING for AC/DC, a HIGH IMPEDANCE ATTENUATOR which gives a grounded input or a signal attenuation of x1-x10 or x100, an IMPEDANCE CONVERTER, a LOW IMPEDANCE ATTENUATOR which gives signal attenuation of x1-x2,5 or x5 and a GAIN x1-x10
AMPLIFIER block, incorporated with the CONTINUOUS CIRCUIT. This block has a variable gain, influenced by the front-panel VAR control. The gain is also increased by x10 in order to obtain 2-5 and 10mV settings

Similar to the vertical channels, the external channel attenuator alsc has an input SIGNAL COUPLING, HIGH IMPEDANCE ATTENUATOR and IMPEDANCE CONVERTER in line. However, the external channel has only x1 attenuation and no LOW IMPEDANCE ATTENUATOR. The output of the external channel is fed to both MTB and DTB TRIGGER PRE-AMPLIFIERS.

All blocks that are capable of working in different modes are controlled by the control A or control B signals. These signals are generated by the CH.A CONTROL or CH.B CONTROL blocks.

3.2.4 Pre-amplifier unit

This unit incorporates the signal splitters for the vertical channels and B, the trigger view amplifier, the trigger circuits for the MTB an DTB and the chopper oscillator circuit. All these functions are controlled by the control XYP and control XYA signals, generated by the X-Y CONTROL blocks.

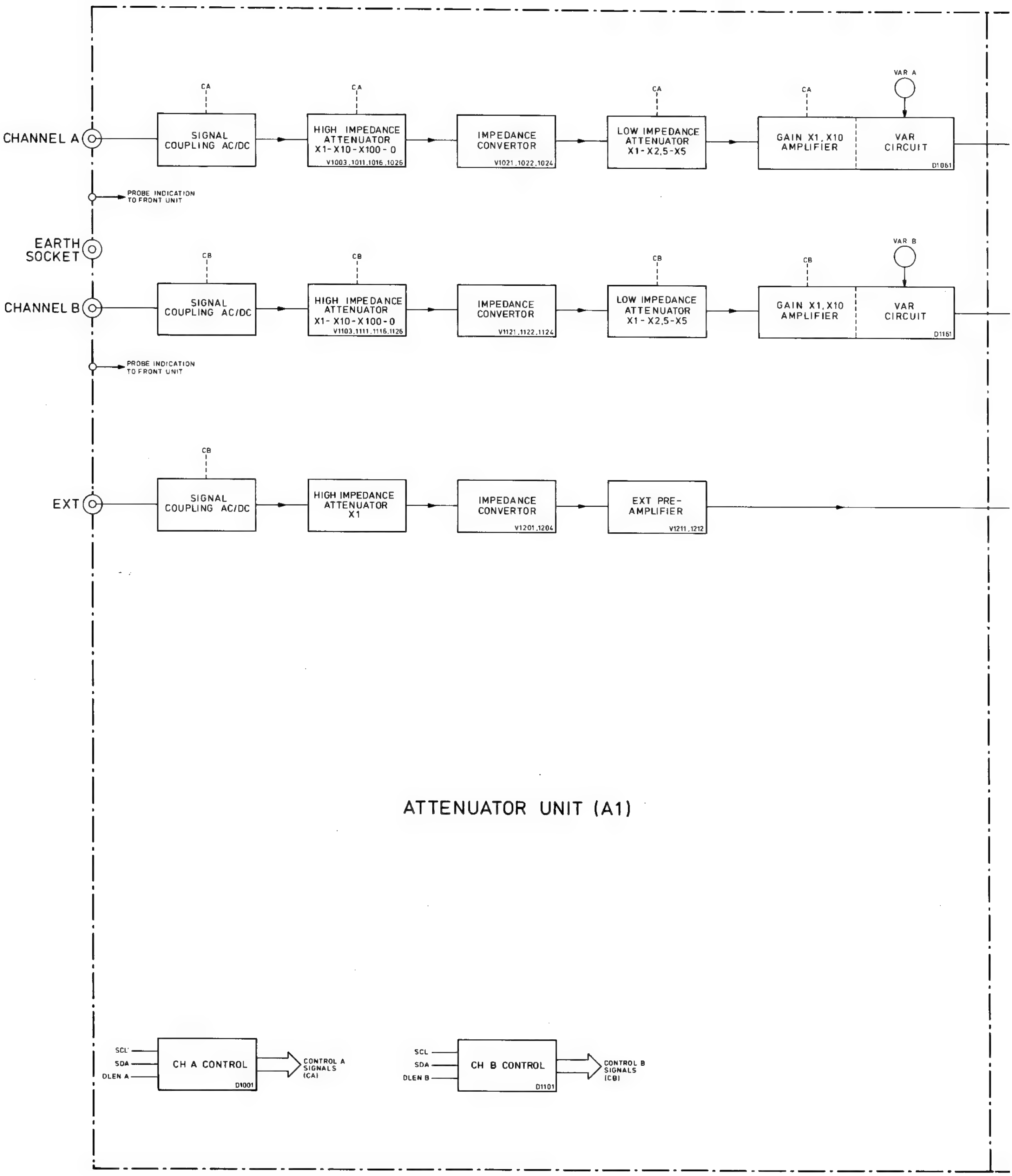
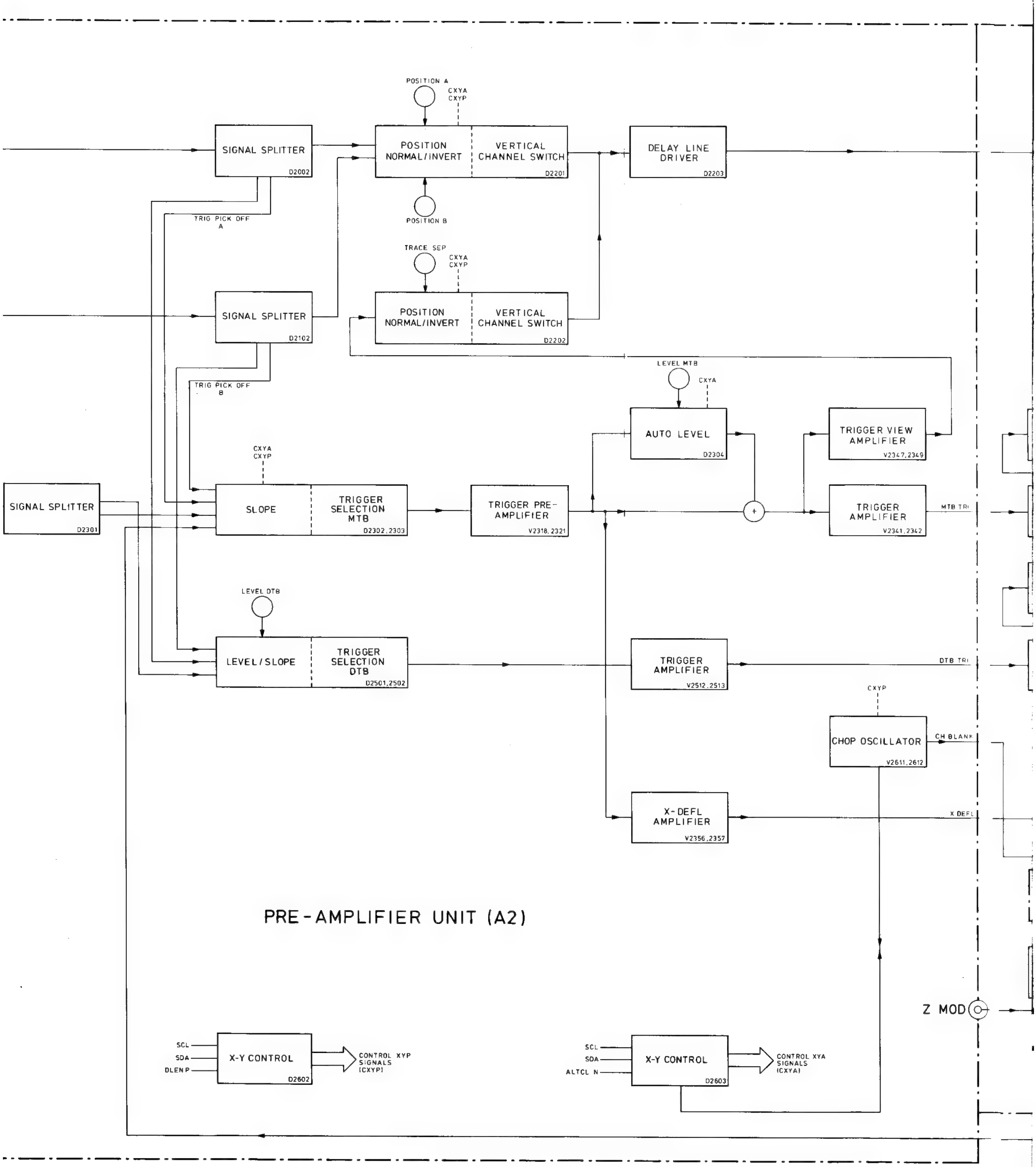
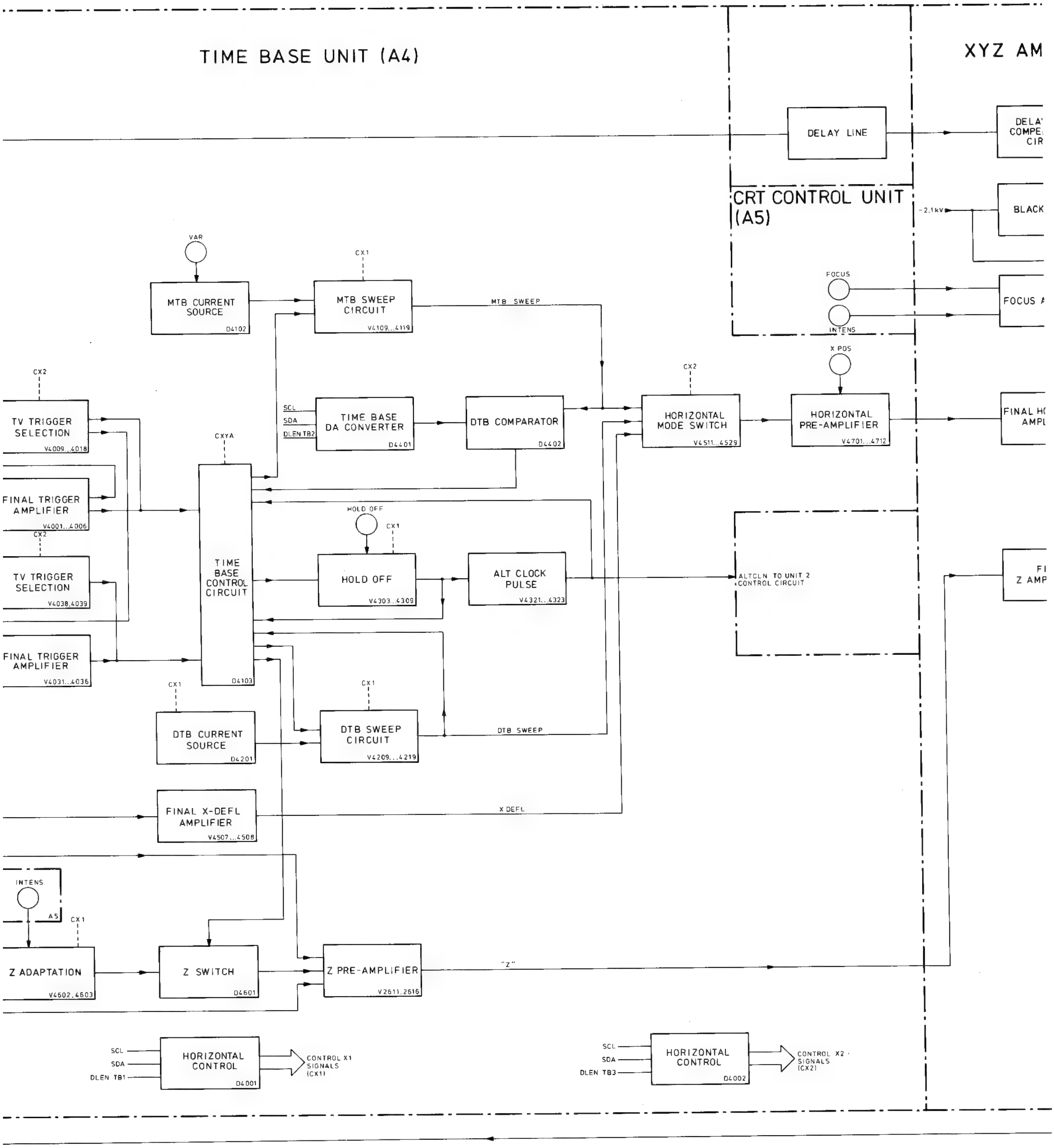


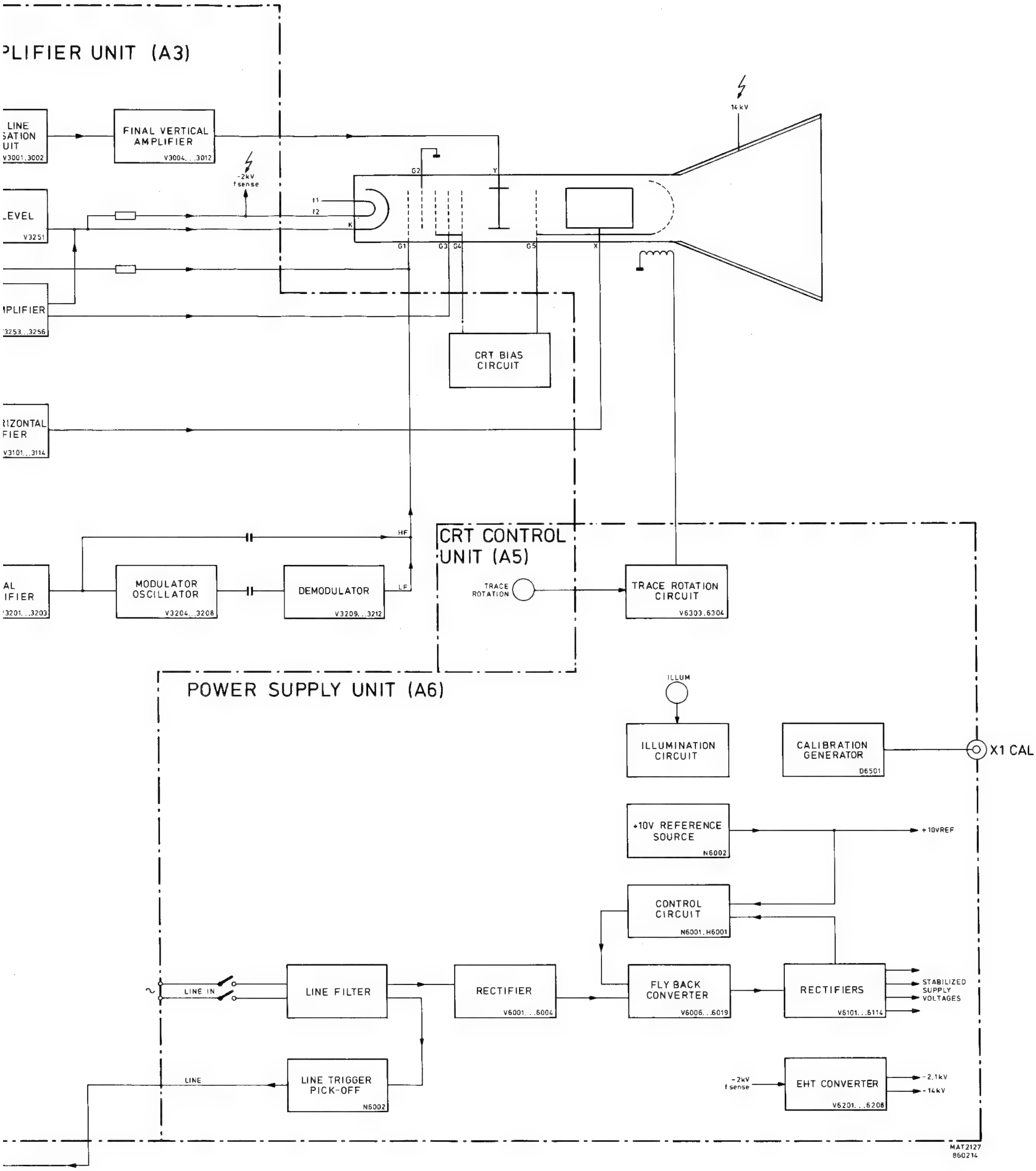
Figure 3.1 Block diagram



PRE-AMPLIFIER UNIT (A2)
SIGNAL SPLITTER D2002
SIGNAL SPLITTER D2102
SIGNAL SPLITTER D2301
POSITION A
POSITION B
TRACE SEP
CXYA CXYP
POSITION NORMAL/INVERT
VERTICAL CHANNEL SWITCH D2201
VERTICAL CHANNEL SWITCH D2202
DELAY LINE DRIVER D2203
TRIG PICK OFF A
TRIG PICK OFF B
LEVEL MTB
CXYA
AUTO LEVEL D2304
TRIGGER VIEW AMPLIFIER V2347,2349
SLOPE
TRIGGER SELECTION MTB D2302,2303
TRIGGER PRE-AMPLIFIER V2318,2321
TRIGGER AMPLIFIER V2341,2342
MTB TRI
LEVEL DTB
LEVEL/SLOPE
TRIGGER SELECTION DTB D2501,2502
TRIGGER AMPLIFIER V2512,2513
DTB TRI
CXYP
CHOP OSCILLATOR V2611,2612
CH BLANK
X-DEFL AMPLIFIER V2356,2357
X DEFL
Z MOD
SCL
SDA
DLEN P
X-Y CONTROL D2602
CONTROL XYP SIGNALS (CXYP)
SCL
SDA
ALTCL N
X-Y CONTROL D2603
CONTROL XYA SIGNALS (CXYA)



TIME BASE UNIT (A4)
CRT CONTROL UNIT (A5)
XYZ AM
DELAY LINE
DELA COMPE CIR
BLACK
-2.1kV
FOCUS
INTENS
FOCUS
X POS
FINAL H AMPL
VAR
MTB CURRENT SOURCE
D4102
CX1
MTB SWEEP CIRCUIT
V4109...4119
MTB SWEEP
CX2
TV TRIGGER SELECTION
V4009...4018
SCL
SDA
DLEN TB2
TIME BASE DA CONVERTER
D4401
DTB COMPARATOR
D4402
HORIZONTAL MODE SWITCH
V4511...4529
HORIZONTAL PRE-AMPLIFIER
V4701...4712
CXYA
FINAL TRIGGER AMPLIFIER
V4001...4006
TIME BASE CONTROL CIRCUIT
D4103
HOLD OFF
HOLD OFF
V4303...4309
ALT CLOCK PULSE
V4321...4323
ALTCLN TO UNIT 2 CONTROL CIRCUIT
FI Z AMP
TV TRIGGER SELECTION
V4038,4039
FINAL TRIGGER AMPLIFIER
V4031...4036
DTB CURRENT SOURCE
D4201
DTB SWEEP CIRCUIT
V4209...4219
DTB SWEEP
FINAL X-DEFL AMPLIFIER
V4507...4508
X DEFL
INTENS
A5
Z ADAPTATION
V4602,4603
Z SWITCH
D4601
Z PRE-AMPLIFIER
V2611,2616
"Z"
HORIZONTAL CONTROL
D4001
DLEN TB1
CONTROL X1 SIGNALS (CX1)
HORIZONTAL CONTROL
D4002
DLEN TB3
CONTROL X2 SIGNALS (CX2)



PLIFIER UNIT (A3)
LINE
SATION
UIT
V3001, 3002
FINAL VERTICAL
AMPLIFIER
V3004...3012
-2kV
f sense
14 kV
G2
Y
f1
f2
K
G1
G3
G4
G5
X
LEVEL
V3251
PLIFIER
3253...3256
CRT BIAS
CIRCUIT
IZONTAL
FIER
V3101...3114
HF
LF
AL
IFIER
3201...3203
MODULATOR
OSCILLATOR
V3204...3208
DEMODULATOR
V3209...3212
CRT CONTROL
UNIT (A5)
TRACE
ROTATION
TRACE ROTATION
CIRCUIT
V6303, 6304
POWER SUPPLY UNIT (A6)
ILLUM
ILLUMINATION
CIRCUIT
CALIBRATION
GENERATOR
D6501
X1 CAL
+10V REFERENCE
SOURCE
N6002
+10VREF
CONTROL
CIRCUIT
N6001, H6001
LINE IN
LINE FILTER
RECTIFIER
V6001...6004
FLY BACK
CONVERTER
V6006...6019
RECTIFIERS
V6101...6114
STABILIZED
SUPPLY
VOLTAGES
LINE
LINE TRIGGER
PICK-OFF
N6002
-2kV
f sense
EHT CONVERTER
V6201...6208
-2,1kV
-14kV
MAT2127
860214

* Vertical channels A and B:

Both channels are completely identical and receive their input signals from the ATTENUATOR UNIT. This signal is applied to the SIGNAL SPLITTER, which has three outputs:

- two outputs applied to the SLOPE/TRIGGER SELECTIONS for MTB or DTB triggering.
- a third output routed to the POSITION/NORMAL-INVERT block.

This block is incorporated with the VERTICAL CHANNEL SWITCH in a single IC. Vertical shift of the displayed signal is achieved by the front-panel POSITION control. The output of this block and the output of the TRIGGER VIEW channel are routed via the DELAY LINE DRIVER to the DELAY LINE. The TRIGGER VIEW channel enables display of the MTB trigger source and can be used as a third vertical channel with limited specifications. The front-panel TRACE SEP control influences the position of the trace of the DTB signals related to the trace of the MTB signal.

* MTB trigger circuit:

The SLOPE/TRIGGER SELECTION block receives a trigger signal from one of the vertical channels A or B, from the EXT SIGNAL SPLITTER or from the LINE TRIGGER PICK-OFF. Inverting of the trigger signal is controlled by the CXYA signalsINVAM and INVBM to obtain the MTB slope function.Routed via the TRIGGER PRE-AMPLIFIER, block the signal is split up into three different paths:

- after summation of the LEVEL signal, direct to the TRIGGER AMPLIFIER
- to the AUTO LEVEL block. This block contains the different trigger facilities and levelling of the trigger signal is influenced by the front-panel LEVEL control. The output of this path is routed again to the summation point to influence the direct trigger signal.
- to the X-DEFL AMPLIFIER for X-deflection facility. This block incorporates a phase correction circuit for the X-Y display.

  The TRIGGER AMPLIFIER feeds the MTB trigger signal to the time-base unit. The trigger signal from the summation point is also routed via the TRIGGER VIEW AMPLIFIER to the vertical CHANNEL SWITCH stage to display this signal.

* DTB trigger circuit:

Basically, for triggering purposes this circuit is identical to the MTB trigger circuit. This circuit also has a SLOPE/TRIGGER SELECTION and TRIGGER AMPLIFIER block. However, the DTB trigger circuit has no LINE trigger or AUTO LEVEL facility. The LEVEL control directly influences the SLOPE/TRIGGER SELECTION block.

* Chopper oscillator circuit:

A square-wave signal for chopper blanking and vertical switching is generated in the CHOP OSCILLATOR. For chopper blanking the signal is routed to the Z PRE-AMPLIFIER on the time-base unit.

3.2.5 Time-base unit

This unit incorporates the main time-base (MTB), the delayed time-base (DTB), the horizontal amplifier and the Z amplifier circuit. All functions are controlled by the CX1 and CX2 signals, generated by the HORIZONTAL CONTROL CIRCUIT blocks.

* Main time-base (MTB):

The MTB trigger signal can be either directly routed to the TIME-BASE CONTROL CIRCUIT or first routed via the TV TRIGGER SELECTION for the TV trigger coupling. When in the AUTO mode, in the absence of trigger signals, the MTB will be free running.

The MTB CURRENT SOURCE applies the sawtooth charging current to the MTB sweep circuit. This block generates the MTB sawtooth signal, which is routed to the HORIZONTAL DISPLAY MODE SWITCH.

The HOLD OFF and the ALT CLOCK PULSE blocks are also under control of the TIME BASE CONTROL CIRCUIT. Hold off time is varied by the front-panel HOLD OFF control. The output of the HOLD OFF block is routed to the TIME-BASE CONTROL CIRCUIT again.

The ALTCLN-pulse is applied to the PRE-AMPLIFIER UNIT.

3.2.6 XYZ unit

This unit comprises the final amplifiers for the vertical (Y) and horizontal (X) deflection and for the blanking (Z) circuit. In addition to this, the CRT control circuits are also incorporated in the unit.

* Final vertical amplifier:

The output signal from the pre-amplifier unit is first routed via the DELAY LINE to give sufficient delay to ensure that the steep leading edges of fast signals are displayed and then fed to the DELAY LINE COMPENSATION. This block compensates the signal for distortion originating in the DELAY LINE before it is applied to the FINAL VERTICAL AMPLIFIER. The output of the FINAL VERTICAL AMPLIFIER feeds the vertical deflection plates of the CRT.

* Final horizontal amplifier:

The horizontal deflection signal is routed to the FINAL HORIZONTAL AMPLIFIER, the output of which feeds the horizontal deflection plates of the CRT.

* Blanking circuit:

The output signal from the Z PRE-AMPLIFIER of the time-base unit, that determines trace blanking or unblanking and modulation is routed to the FINAL Z-AMPLIFIER. After amplification the blanking signal is split into two paths:

- the h.f. signals are fed via a high voltage capacitor to grid G1 of the CRT.
- the l.f. signals are used to modulate the amplitude of an oscillator wave-form, which then passes via another high voltage capacitor and is demodulated in the DEMODULATOR block to retrieve the original signal.

Note that the original h.f. and l.f. signals are again recombined on the grid G1.

* CRT control circuits:

The FOCUS AMPLIFIER block is influenced by both front-panel FOCUS and INTENS controls to provide a focus that is independent of the intensity, and drives the focusing grid G3 of the CRT.

The -100 V BLACK LEVEL block provides the correct presetting of the cathode voltage.

The CRT BIAS gives a d.c. voltage to the grids G4 and G5 to provide an optional adjustment for geometry and astigmatism.

3.2.7 Power supply unit

The mains input voltage is filtered and then applied to the RECTIFIER block to obtain a d.c. voltage source. Another output of the LINE FILTER block is routed via the LINE TRIGGER PICK-OFF and serves as a MTB LINE trigger signal. The rectified mains source is routed to the FLYBACK CONVERTER, which generates the necessary voltages for the oscilloscope circuits. Each supply voltage is rectified in the RECTIFIERS block.
The LOW-voltage supplies are stabilized by the CONTROL circuit to the converter.
The +10 V REF supply serves as a low-voltage reference and is generated in the +10 V REFERENCE source block. This reference voltage is also fed to the different circuits on the power supply or in the oscilloscope.

The EHT CONVERTER generates the -14 kV for the post-accelerator anode of the CRT and the -2 kV for the cathode circuits.

* Auxiliary circuits:

The CALIBRATION GENERATOR generates the CAL voltage, which is applied to the output socket X1. The CAL voltage has a 1,2 V p-p level with a frequency of 2kHz square wave.

The ILLUMINATION CIRCUIT determines the amount of current passed to the graticule illumination lamp of the CRT controlled by the ILLUM control on the front-panel.

The TRACE ROTATION CIRCUIT determines the strength and sense of the current passed to the trace rotation coil around the neck of the CRT. The current is influenced by the front-panel screwdriver operated TRACE ROT control.

4. ATTENUATOR UNIT (A1)

4.1 VERTICAL ATTENUATORS

The A and B channel attenuators are identical: therefore only channel A is described.

All relay and FET switches are controlled by the microcomputer via the I^2C bus. The TEA 1017 converts this serial DATA into the parallel control signals for all relay or FET switches. A list of the control lines for all attenuator settings is given in the table below.

	X1H	X10H	X100H	X1F	X10F	X100F	X1L	X2,5L	X5L	X1/X10
2mV	●			●			●			●
5mV	●			●				●		●
10mV	●			●					●	●
20mV	●			●			●			
50mV	●			●				●		
1V	●			●					●	
2V		●			●		●			
5V		●			●			●		
1V		●			●				●	
2V			●			●	●			
5V			●			●		●		
10V			●			●			●	

MAT 2227

Figure 4.1 Table of attenuator settings

The channel A attenuator consists of in five stages:

Input coupling, where depending on the relay K1001 position, the input signal can either be d.c.-coupled (relay activated) or a.c.-coupled (relay not activated).

High impedance attenuator with three attenuator stages for the x1, x10 and x100 attenuation. The l.f. part of each stage is split via a resistor divider and routed via N1001 and V1019 to the output of this stage, where it is re-connected with the h.f. part of the input signal. Potentiometers R1036 (TRACE jump) serves as a offset compensation for N1001.

	RELAY	FET	TRIMMER FOR L.F. SQUARE WAVE	L.F. RESISTOR DIVIDER
x 1	K1004	V1011	C1033	--
x 10	K1003	V1006	C1029	R1007-R1011
x100	K1002	V1003	C1023	R1019-R1004

Note that, when "0" (GND-A) is selected, the output is connected to ground via FET V1016 and all other relay- and FET switches are switched off.

The impedance converter serves as an inverting buffer circuit for the high impedance attenuator. For the l.f.-feedback the output signal of this stage is routed to the l.f. summation point N1001-2.

The low impedance attenuator reduces the gain by x1, x2.5 and x5, depending on which relay is activated.

	RELAY	RESISTOR DIVIDER
x1	K1006	--
x2.5	K1007	R1053 vs R1056, R1057 and R1058
x5	K1008	R1053, R1056 and R1057 vs R1058

The continuous circuit (OQ0203), the differential input voltages of which are fed to pins 4 and 5.
This stage comprises the following functions:

- Continuously variable control (pin 11).
- Gain x1 (pin 2 and 3) with offset adjustment R1064 (R1164) and gain adjustment R1069 (R1169).
- Gain x10 (pin 6 and 7) with offset adjusting R1072 (R1172) and gain adjustment R1076 (R1176).
- x1/x10 control, (pin 10) to select the 2,5 and 10 mV/DIV settings.

The differential output current from pin 13 and pin 14 is routed via a common-base circuit V1063, V1064 and applied to the pre-amplifier unit.

4.2 EXTERNAL INPUT

The external input can be subdivided into four stages:

Input coupling, basically similar to the ch.A input coupling.

High impedance attenuator for the x1 attenuator only, where the l.f. square-wave can be adjusted with trimmer C1206. The l.f. part is routed to the summation point N1201-2. R1217 serves as an offset compensation for N1201. For l.f.-feedback the output of the impedance converter is also routed to this summation point.
Note that the output of this stage is also a reconstituted version of the input signal.

Impedance converter, is basic similar to the ch.A impedance converter.

The differential amplifier V1211, V1212 converts the voltage from emitter-follower V1209 into the differential current signals EXT+ and EXT-. This signal is applied to the pre-amplifier unit and serves as external trigger signal or as an external deflection signal.
The current for this stage is applied from current source V1213.

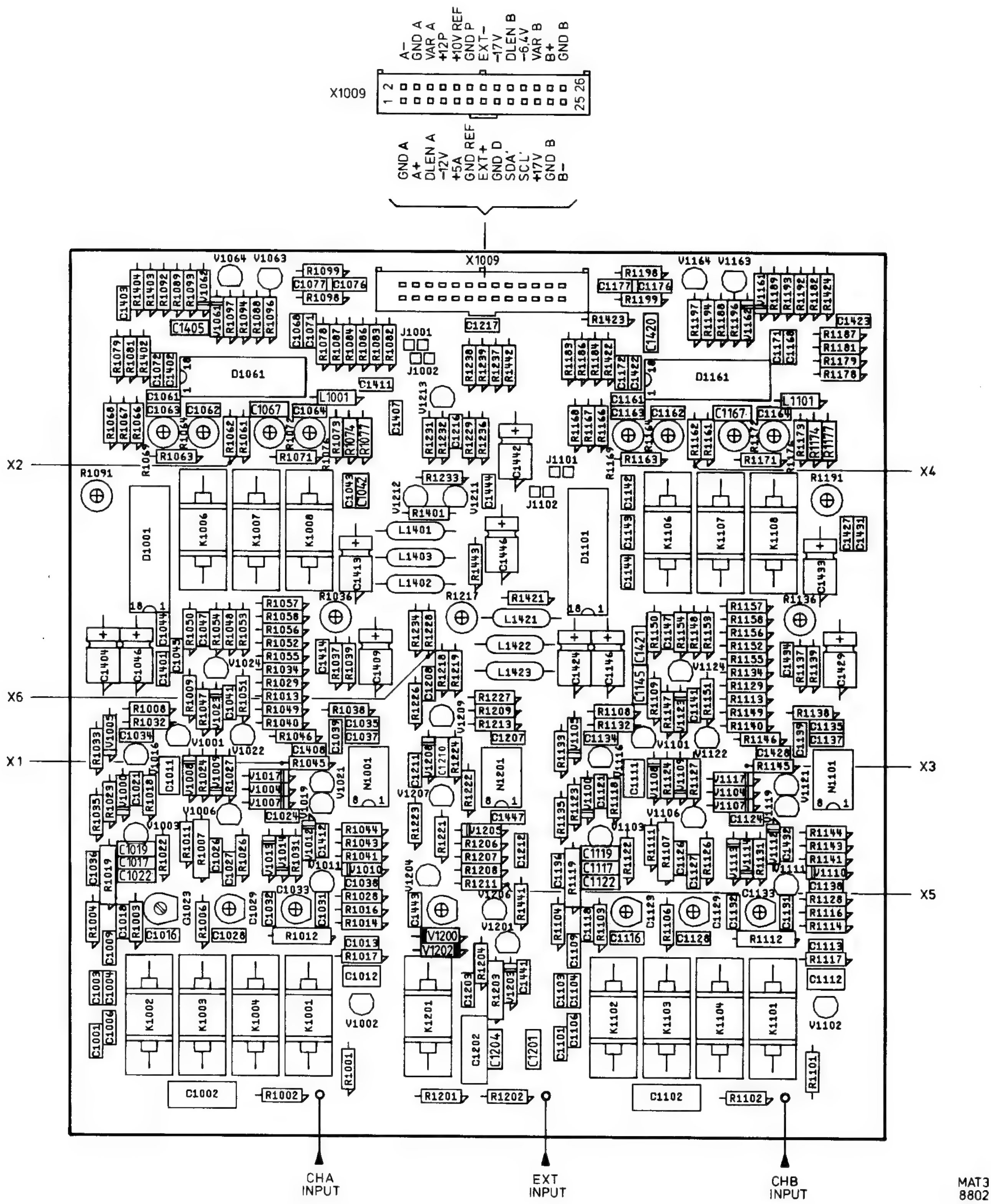


Figure 4.2 Attenuator unit p.c.b.

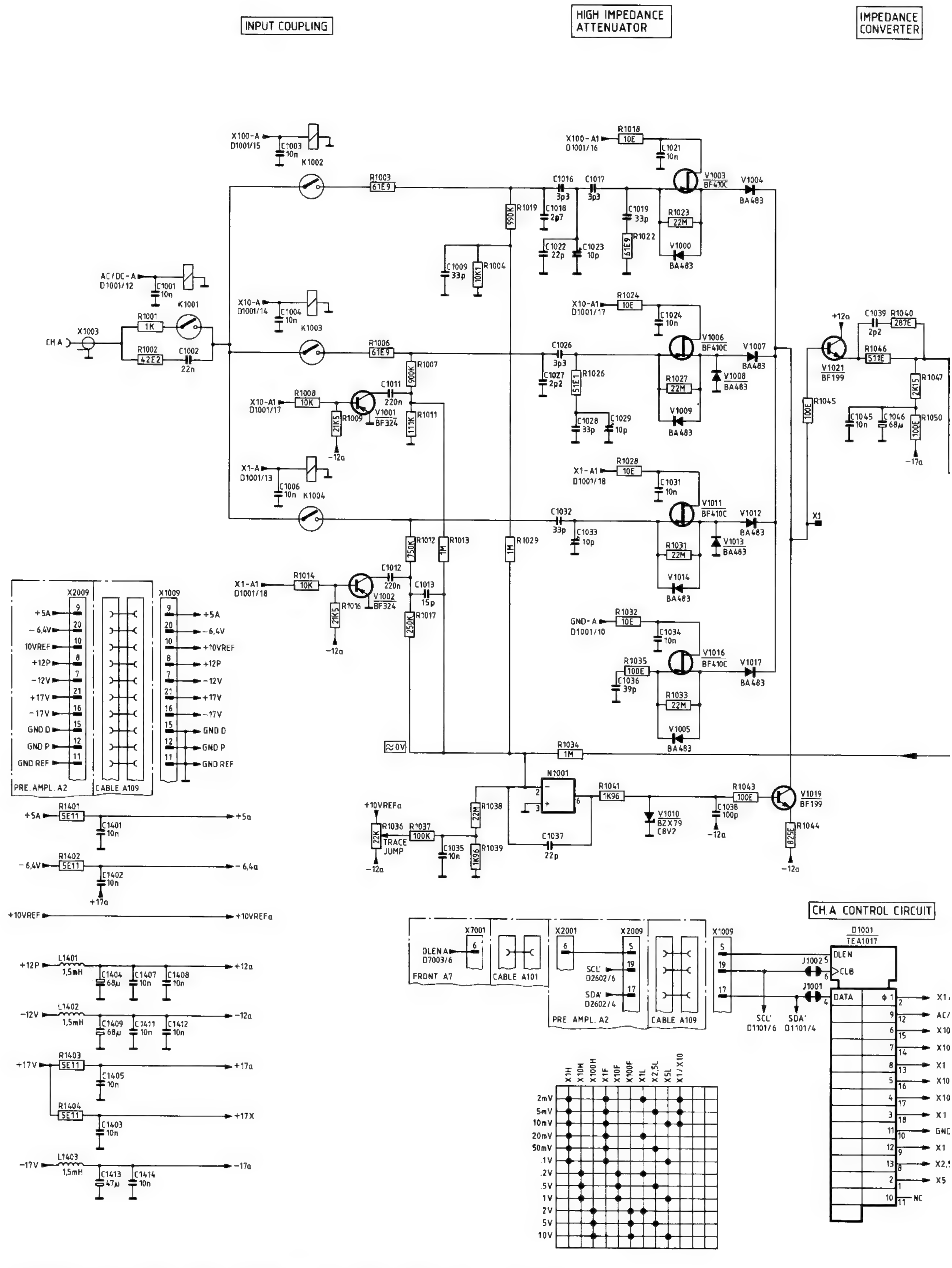
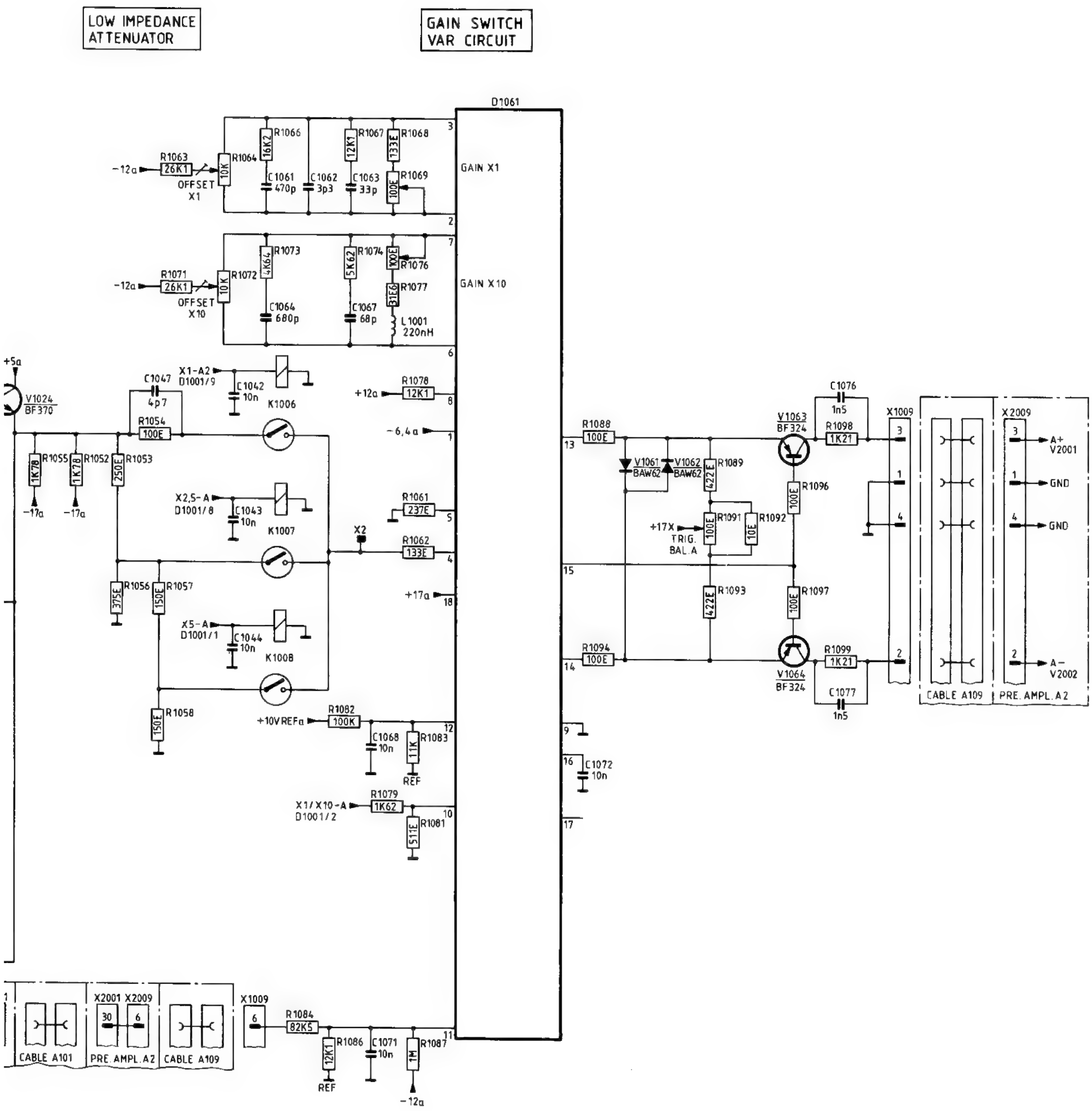
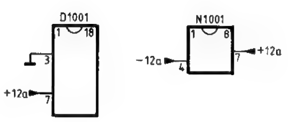


Figure 4.3 Circuit diagram of attenuator, ch. A



REF NO.	TYPE
D1001	TEA1017
D1061	OQ0203
N1001	μA714



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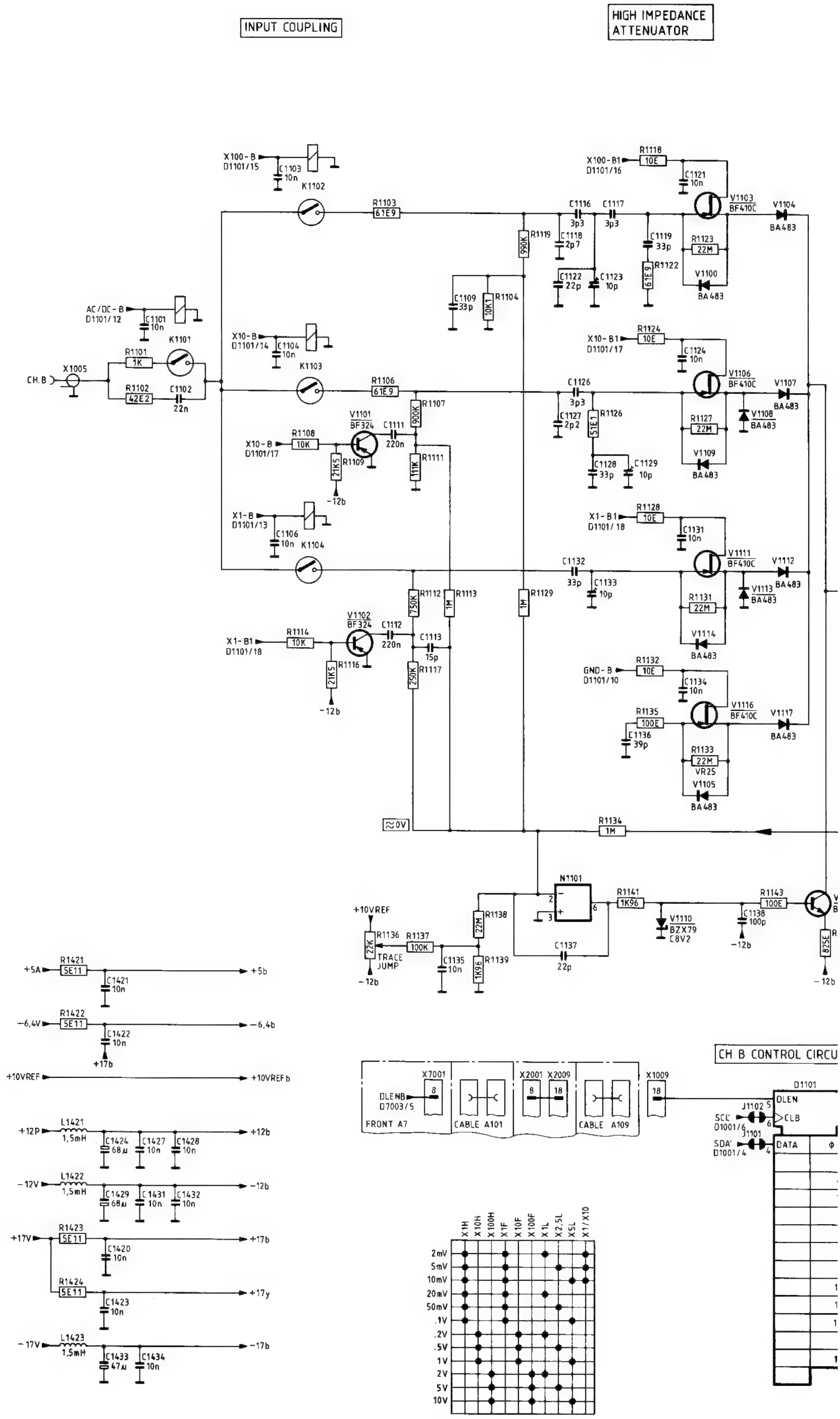
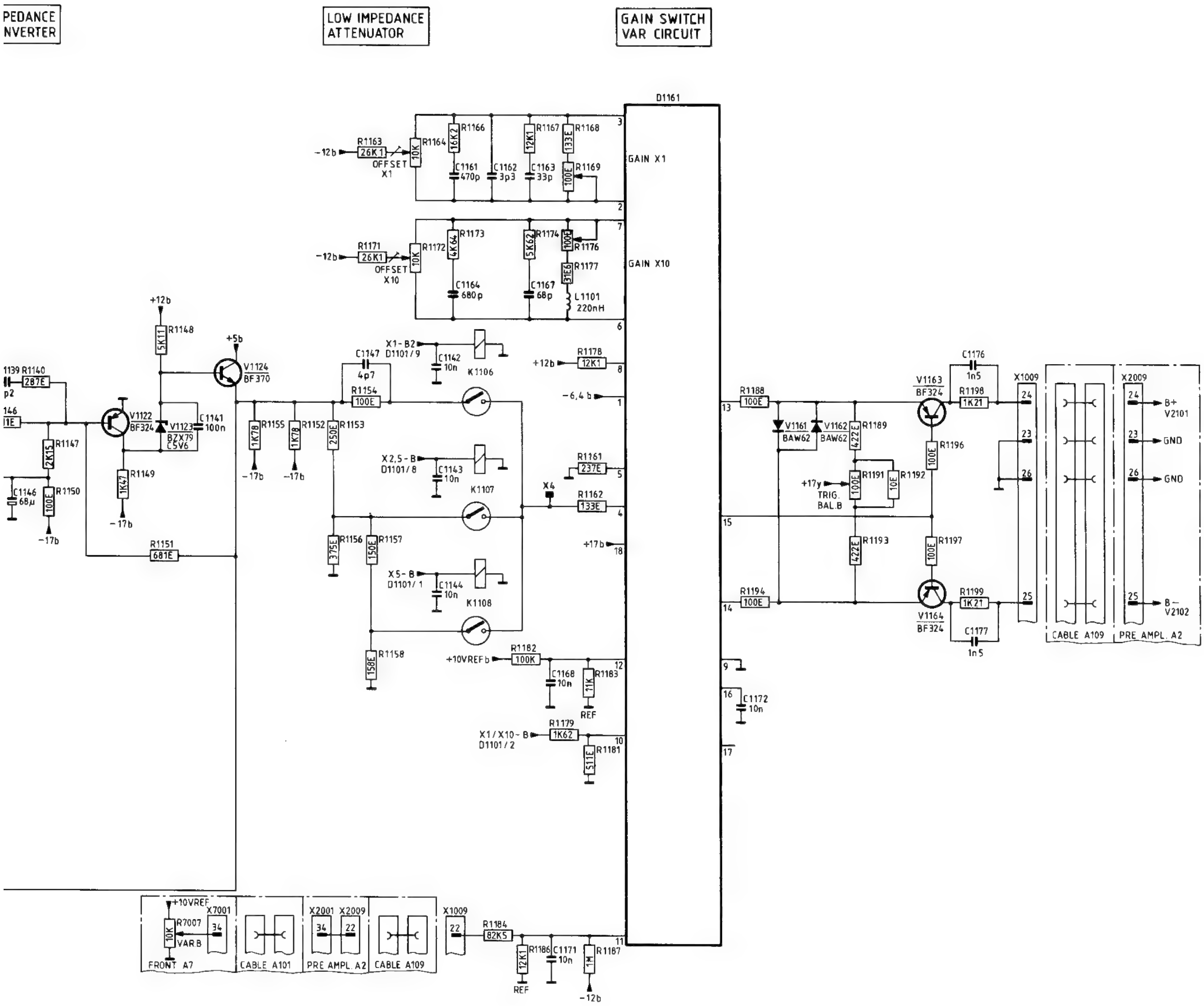
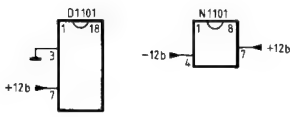


Figure 4.4 Circuit diagram of attenuator, ch. B



REF NO	TYPE
D1101	TEA1017
D1161	OQ0203
N1101	μA714



I0-B R1179
:-B K1101
B K1102
K1103
K1104
31 R1118
1 R1108 / R1124
R1114 / R1128
B R1132
! K1106
3 K1107
K1108
: EXT K1201

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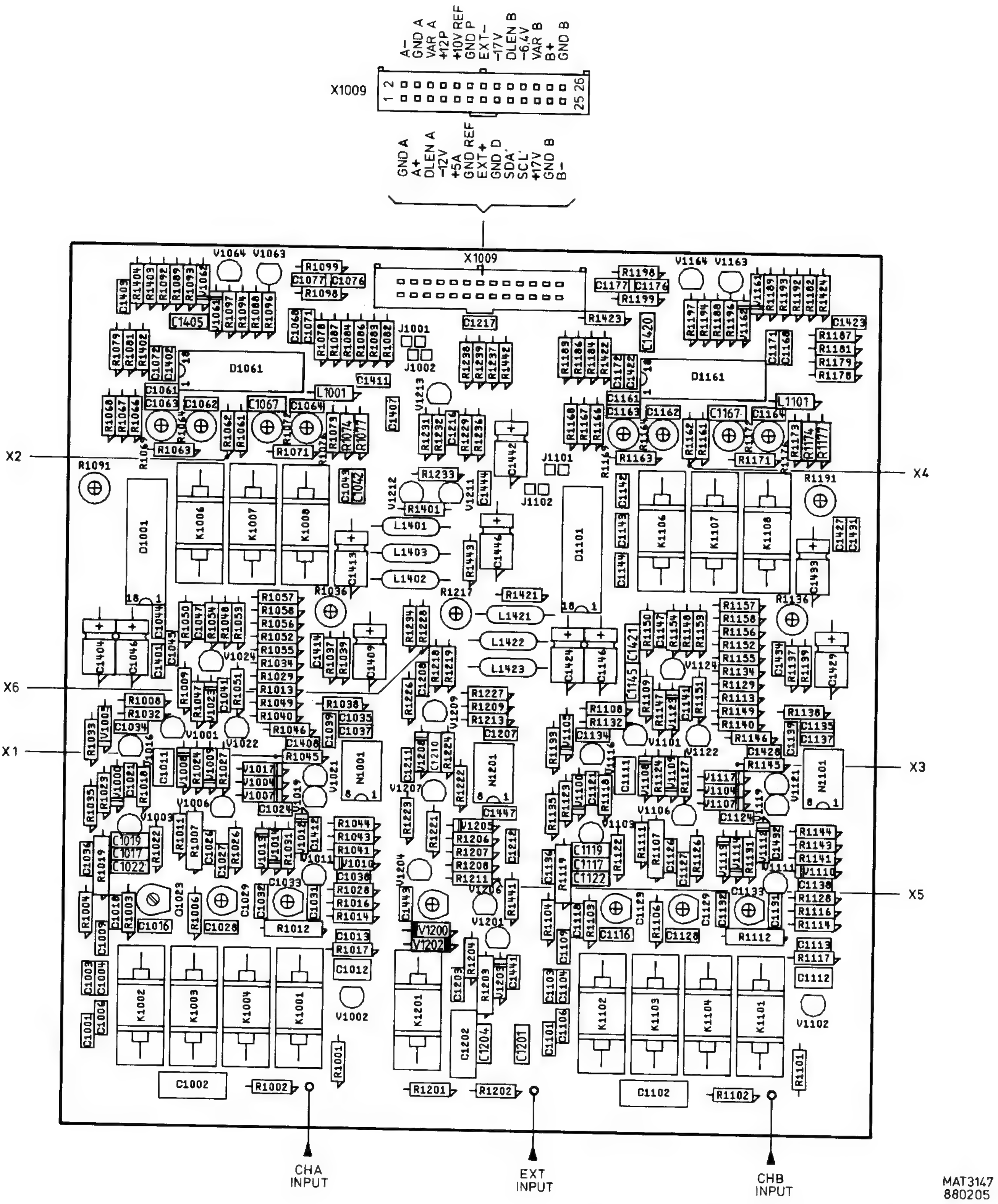
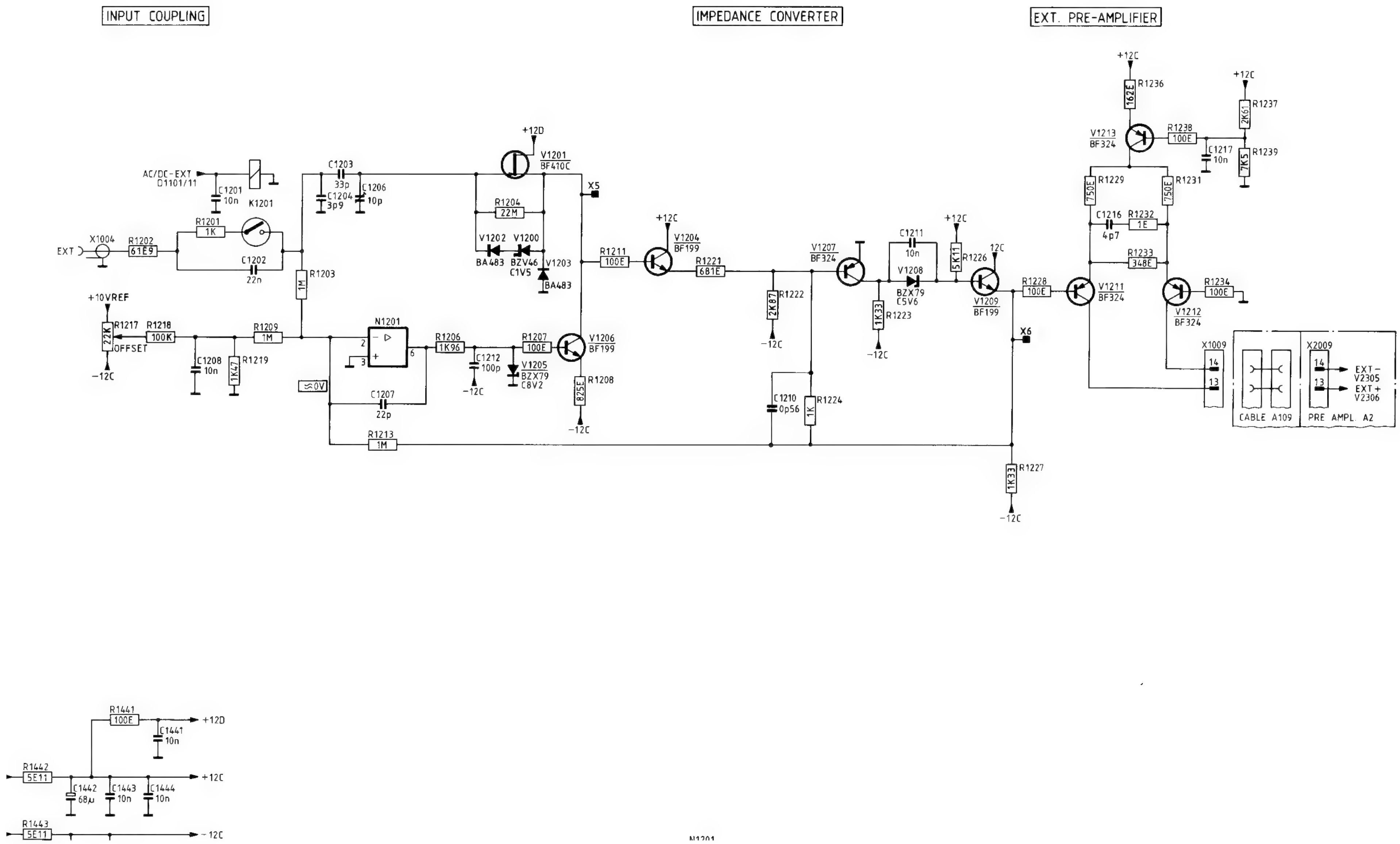


Figure 4.5 Attenuator unit p.c.b.


INPUT COUPLING
IMPEDANCE CONVERTER
EXT. PRE-AMPLIFIER
AC/DC-EXT
D1101/11
C1201 10n
K1201
X1004
EXT
R1202 61E9
R1201 1K
C1202 22n
R1203 1M
C1203 33p
C1204 3p9
C1206 10p
+12D
V1201 BF410C
R1204 22M
V1202 BA483
V1200 BZV46 C1V5
V1203 BA483
X5
+10VREF
R1217 22K OFFSET
-12C
R1218 100K
C1208 10n
R1219 1K47
R1209 1M
N1201
≈0V
C1207 22p
R1213 1M
R1206 1K96
C1212 100p
R1207 100E
V1205 BZX79 C8V2
V1206 BF199
R1208 825E
R1211 100E
+12C
V1204 BF199
R1221 681E
R1222 2K87
V1207 BF324
C1210 0p56
R1224 1K
C1211 10n
V1208 BZX79 C5V6
R1223 1K33
R1226 5K11
V1209 BF199
X6
R1227 1K33
R1228 100E
V1211 BF324
R1236 162E
V1213 BF324
R1238 100E
R1237 2K61
C1217 10n
R1239 7K5
R1229 750E
R1231 750E
C1216 4p7
R1232 1E
R1233 348E
V1212 BF324
R1234 100E
X1009
CABLE A109
X2009
PRE AMPL. A2
EXT- V2305
EXT+ V2306
R1441 100E
C1441 10n
+12D
R1442 5E11
C1442 68µ
C1443 10n
C1444 10n
+12C
R1443 5E11
-12C
N1201

5. PRE-AMPLIFIER UNIT (A2)

The pre-amplifier unit consists of:

- Vertical pre-amplifier
- MTB trigger pre-amplifier
- DTB trigger pre-amplifier
- Pre-amplifier control, incl. CHOPPER oscillator.

All control pulses for this unit are generated by the pre-amplifier control circuit, via the I^2C bus (see section 5.4).

5.1 VERTICAL PRE-AMPLIFIER

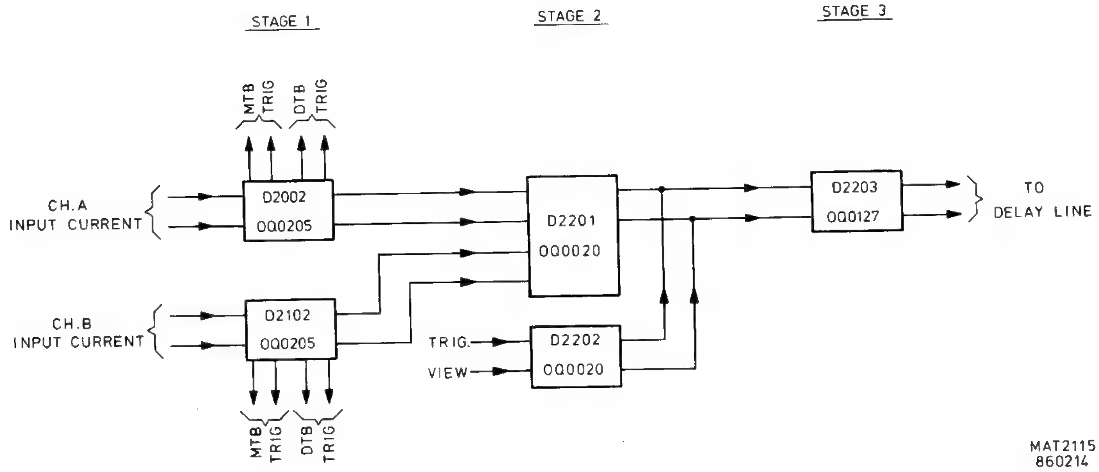


Figure 5.1 The three stages of the vertical pre-amplifier

The vertical pre-amplifier consists of three stages.

The signal splitter (Q0205) receives its input signal for channel A (B) from the attenuator unit and copies this signal into three identical differential output current signals for:

- Vertical channel (pin 7 and 10)
- MTB triggering (pin 5 and 12), see section 5.2.
- DTB triggering (pin 4 and 13), see section 5.3.

Stage 2 (OQ0020) consists of two integrated circuits D2201 and D2202, connected in parallel and serves as a vertical channel switch. The switch selection is as follows:

	D2201 pin 10	D2201 pin 11	D2202 pin 10
A	1	0	0
B	0	1	0
TRIG VIEW	0	0	1
ADD	1	1	0

Further, all possible 2, 3, or 4 channel combinations are possible in alternated or chopped display (see also section 5.4).

This stage comprises the following functions:

- Position control POS A R7006 on D2201-1 for ch. A and POS B R7008 on D2201-8 for ch. B.
- Channel B normal/invert (high is INVERT) on D2201-7. (The balance between normal/invert can be adjusted with R2212).
- Trigger view invert (high is INVERT) on D2202-2.
- Trace separation control with R7013 on D2202-8.

Stage 3 (D2203) serves as delay line driver where the output current of both OQ0020 is converted into voltage signal applied to the delay line. The current for this stage and for D2201 and D2202 is fed via R2231 and R2246.
The current regulation for the common-mode circuit is achieved by transistor D2203 (12, 13, 14).

5.2 MTB TRIGGER PRE-AMPLIFIER

Trigger possibilities are:

	Signal name	Signal routed to	Selected by: name	Selected by: routed to	inverted by: name	inverted by: routed to
ch. A	TRAM+, TRAM-	D2302(3,4)	AM	D2302(10)	INVAM	D2302(2)
ch. B	TRBM+, TRBM-	D2302(5,6)	BM	D2302(11)	INVBM	D2302(7)
EXTERNAL	EXT-, EXT+	D2303(3,4)	EXTM	D2303(10)	INVAM	D2303(2)
line	LINE	D2303(5)	LNM	D2303(11)	INVAM	D2303(7)

D2301 serves as a signal splitter and receives its input signal from the attenuator unit. This input current signal is copied into two identical differential output current signals for:

- EXT MTB signal (pin 6 and 11)
- EXT DTB signal (pin 7 and 10), (see Section 5.3).

The symmetrical output currents from D2302 (13, 14) and D2303 (13, 14) are converted into a symmetrical voltage again in the common-base circuit V2316, V2319 followed by a shunt feedback circuit V2318 and V2321. Note that the sensitivity at the collectors of V2318 and V2321 is 110 mV/DIV.

At this point the signal path is divided into:

- a trigger path, fed to both V2333 and V2334, where depending on the current to the base, levelling of the trigger signal is obtained. Two separate series feedback circuits take care of voltage-to-current conversion:
  * V2341 and V2342 for main time-base triggering. The trigger output signal, TRIGM- and TRIGM+ are fed to the time-base unit A4.
  * V2347 and V2349 for trigger view. This symmetrical output can be balanced by potentiometer R2407 (Trig view BAL). The TRIGV+ and TRIGV- signals are fed to D2202 (3-4).

Integrated circuit D2304 serves as an auto level circuit.
The following functions are possible.

a. Peak-peak

In this case the amplitude of the trigger signal applied to D2304 (3,7) is measured by peak-peak detectors on D2304 (2,4,6,8). The output current from D2304 (14,15) is dependent on the peak-peak level and is adjustable with the LEVEL control R7012, connected to D2304(1).

b. Triggering

In this case the level range is 16 div. The level is adjustable with R7012 and the current variation on D2304 (14,15) can be varied between +or- 0,6mA.

c. TV triggering

The level control is made ineffective. In TV triggering, the LEVEL must be set to a fixed value. This is done by applying a high level current to pin 1 via diode V2326.

d. Auto

In auto the signal LEVEL ZERO is high and via diode V2325 the output level D2304 (15) is asymmetrical with output level D2304 (14). Thus the maximum signal amplitude is 2 Vp-p.

- an external deflection path, routed via the series feedback circuit V2356 and V2357, the X DEFL+ and X DEFL- signals are fed to the time base unit A2.
  R2416, R2422 and C2350 gives phase correction for the X-Y display.

5.3 DTB TRIGGER PRE-AMPLIFIER

Trigger possibilities are:

	Signal name	routed to	Selected by: name	routed to	Inverted by: name	routed to
ch.A	TRAD+, TRAD-	D2501(3,4)	AD	D2501(10)	INVAD	D2501(2)
ch.B	TRBD+, TRBD-	D2501(5,6)	BD	D2501(11)	INVBD	D2501(7)
EXTERNAL	EXT+, EXT-	D2502(5,6)	EXTD	D2502(11)	INVAD	D2502(7)

Similar to the main time base triggering, signal splitter D2301 applies the EXT current to the OQ0020.

The LEVEL control R7014 is connected to D2502-1 to obtain a level range of 16 div.

The output of both integrated circuits, pin 13 and 14, are routed via a shunt feedback V2512, V2513, followed by a series feedback circuit V2514, V2516 and provide the DTB trigger signals TRIGD- and TRIGD+. These signals are fed to the time-base unit A4.

5.4 PRE-AMPLIFIER CONTROL

The pre-amplifier control converts the data from the 1^2C bus (SDA and SCL), derived from the microcomputer, into the control pulses for the pre-amplifier unit. To eliminate interference the SDA and SCL lines can be switched off via D2601.

This integrated circuit serves as a digital switch, controlled by the VERT IIC line. Logic high connects the outputs D2601(4,14,15) to the input "1" contact (switched on); logic low connects the outputs to the "2" contact (switched off) and gives SDA a logic low level and SCL a logic high level.

When D2601 is switched on, the serial data information is converted into parallel control pulses via D2602 and D2603, provided that D2602 is enabled (D2602-5 is high). The control lines are active when the level of the line is high.

Output Q12-D2602(9) serves as a power up not line for D2603: when the oscilloscope is in the power-up routine, Q12 is high and resets D2603. After the power-up routine, Q12 goes low and enables D2603.

Integrated circuit D2603 relieves the microcomputer of a number of such functions as:

- trigger view
- chop/alt
- trace separation
- trigger select
- time-base select (fed to time base unit A4)

Adaptation of this I.C. to the oscilloscope version is made by the AD0 and AD1 inputs D2603(15,16).
For this oscilloscope, AD0 must be HIGH and AD1 must be LOW.

Timing for alternate and chopped mode is derived by the ALTCLN and CHOPCL pulses.

The chopper oscillator formed by V2611 and V2612 supplies a square wave voltage of 1,5 Vp-p with a frequency of 1 MHz.

This frequency is defined by two current loops:

- I1 is determined by: V2612(c-e), C2611, R2627 and R2625.
- I2 is determined by: V2611(c-e), C2611, R2628 and R2625.

The duty cycle (I1/I1+I2) is 12% approx.

The square wave on the collector of V2612 serves as a chopper clock pulse for D2603 and gives a 500 kHz display for 2 channels CHOP, 333 kHz display for 3 channels CHOP and 250 kHz for 4 channels CHOP (A-B-TRIG VIEW-ADD).

Note that D2603(8) serves as the chopper switch, which is high when the CHOP softkey is depressed.

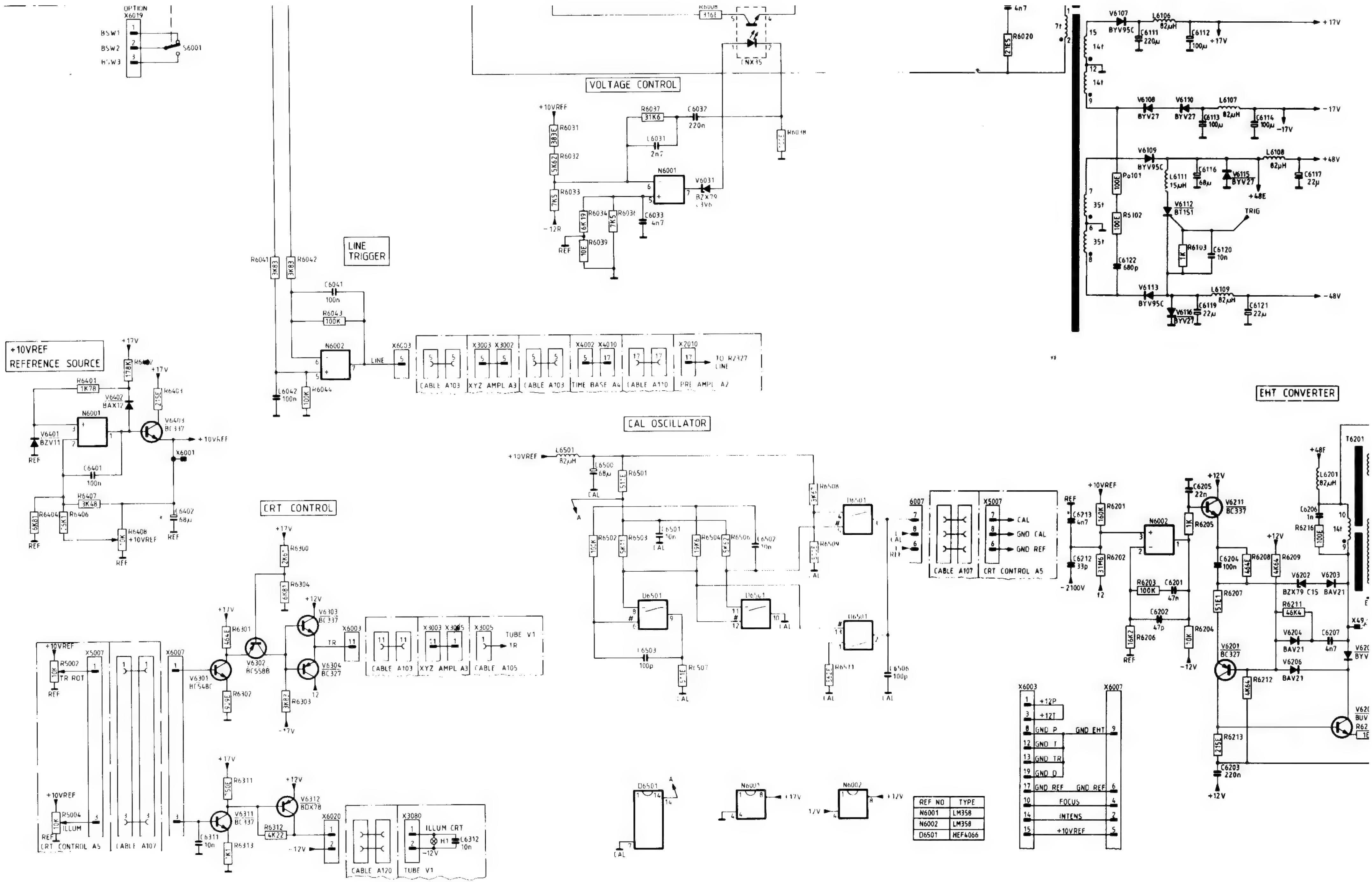


Figure 9.5 Circuit diagram of power supply

14.5 TROUBLE SHOOTING

14.5.1 Introduction

The following information is provided to facilitate trouble shooting. Information contained in other sections of the manual should also be used to locate the defect. An understanding of the circuit is helpful in locating troubles, particularly where integrated circuits are used. Refer to the circuit description for this information.

14.5.2 Trouble-shooting techniques

If a fault appears, the following test sequence can be used to find the defective part:

- Check if the settings of the controls of the oscilloscope are correct. Consult the Operating Instructions.
- Check the equipment to which the oscilloscope is connected and the interconnection cables.
- Check if the oscilloscope is well-calibrated. If not, refer to section 13. "Checking and Adjusting".
- Visually check the part of the oscilloscope in which the fault is suspected. In this way, it is possible to find faults such as bad soldering connections, bad interconnection plugs and wires, damaged components or transistors and IC's that are not correctly plugged into their sockets.
- Location of the circuit part in which the fault is suspected: the symptom often indicates this part of the circuit. If the power supply is defective the symptom will appear in several circuit parts.

After having carried out the previous steps, individual components in the suspected circuit parts must be examined:

- Transistors and diodes.

Check the voltage between base and emitter (0,7 V approx. in conductive state) and the voltage between collector and emitter (0,2 V approx. in saturation) with a voltmeter or an oscilloscope. When removed from the p.c.b. it is possible to test the transistor with an ohmmeter since the base/collector junctions can be regarded as diodes. Like a normal diode, the resistance is very high in one direction and low in the other direction. When measuring take care that the current from the ohmmeter does not damage the component under test.
Replace the suspected component by a new one if you are sure that the circuit is not in such condition that the new component will be damaged.

- Integrated circuits.

In circuit, testing can be done with an oscilloscope or voltmeter. A good knowledge of the circuit part under test is essential. Therefore, first read the circuit descriptions in sections 3...10.

- Capacitors.

Leakage can be traced with an ohmmeter adjusted to its highest resistance range. When testing take care of polarity and maximum allowed voltage. An open capacitor can be checked if the response for AC signals is observed. Also a capacitance meter can used: compare the measured value with the value and tolerance indicated in the parts list

- Resistors.

Can be checked with an ohmmeter after having unsoldered one side of the resistor from the pcb. Compare the measured value with the value and tolerance indicated in the parts list.

- Coils and transformers.

An ohmmeter can be used for tracing an open circuit. Shorted or partially shorted windings can be found by checking the waveform responses when HF signals are passed through the circuit. Also an inductance meter can be used.

- Data latches.

To measure on inputs and outputs of data latches a measuring oscilloscope can be triggered by the clock signal which is connected to the clock input of the data latch.
This measurement can only be made in this way when there is an acceptable repetition time of the clock signal. A too low clock pulse repetition time results in a low intensity of the trace on the measuring oscilloscope screen.
The outputs can easily be checked by a voltmeter or oscilloscope.

14.5.3 Power-up routine

Every time the instrument is switched-on the following initialisation program is executed:

- Resetting the IIC-bus.
- Resetting D2603 (OQ 0200)
- Determinig the SLAVE-address of D2603.
- Checking if Service routine is required (if yes the program will continue with the service routine).
- Checking the "WATCH-DOG" on A7 (if HIGH, all relevant LCD-segments will be lighting for about 1 sec).
- Eventually initialisation of the IEEE-option.

If during the program-run a circuit is found to be faulty, the program stops. It is recommended to switch-off and after a few seconds switch-on again. This will reset the micro-computer controlled system automatically. If the instrument goes in the same faulty situation again, the following procedure indicates how to handle. If no faulure is found, all relevant LCD-segments will be lighting for about one second. After this the normal program is executed.

PROCEDURE:

Check the SDA and SCL lines after haved switched-on. On the SCL a clock-pulse must be present, while the SDA gives the data-information (looks like a random pulse). If one of these signals is not present, you can localize on what unit the fault exists. This can be done by first unplug connector X1009 or X2001 on resp. A1 and A2. To localize what serial-parallel conversion IC is defective, you can disconnect the solder joint in the SDA and SCL print track lead to that IC.
The following IC's can disconnected in this way: D1001, D1101, D2602, D2603, D4001, D4002, D4401.

When the instrument restarts every time again, this means the WATCHDOG is initiating the main program (see also section 10.1.4), the watchdog can be disabled. This can be done by means of the solder joint jumper on the rear of the front unit p.c.b. (near X7001).
When disabled, pin 13 of the microcomputer is set to a low level.

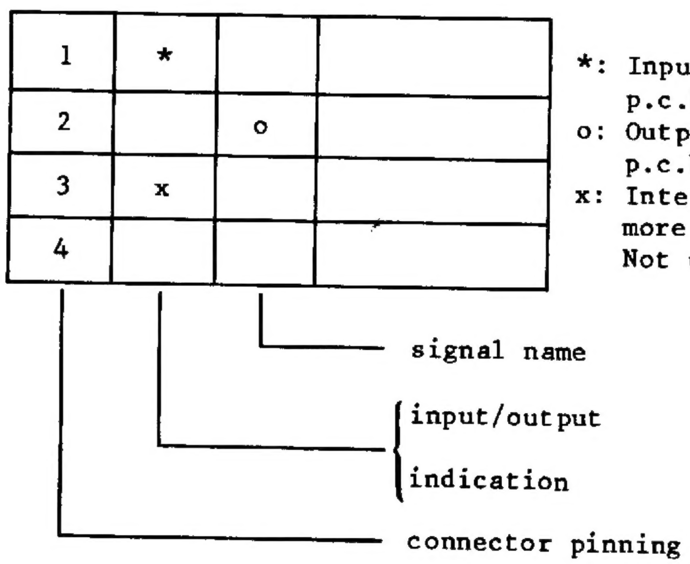
14.5.4 Trouble-shooting the power supply

To determine whether a certain fault condition is initiated by the power supply itself or by the connected oscilloscope circuits, a dummy load is listed in the table below. The table gives also an example of the resistor types that can be used to compose the dummy load. These resistors can be ordered at Concern Service.

Supply voltage	Output current	Dummy resistance and their service ordering numbers
+ 5 V	2,4 A	2,1E-12W: 3 x 8E (4822 112 21052) and 10E (4822 112 21054) in parallel.
- 6,4 V	930 mA	6,9E-6W: 8,2E (4822 112 41052) and 47E (4822 110 23072) in parallel.
+ 12 V	720 mA	17,2E-8,7W: 33E (4822 112 41067) and 39E (4822 112 43069) in parallel.
- 12 V	500 mA	24,7E-6W: 39E (4822 112 41069) and 68E (4822 112 41067) in parallel.
+ 17 V	340 mA	51E-6W: 1E (4822 110 23027) in serial with 2 x 100 E(4822 112 41081) in parallel.
- 17 V	100 mA	171E-1,7W: 270E (4822 110 43092) and 470E (4822 110 43098) in parallel.
+ 48 V	140 mA	341E-7W: 330E (4822 112 41094) in serial with 12E(4822 110 23056).
- 48 V	40 mA	1k22-2W: 2k2 (4822 110 23116) and 2k7 (4822 110 23118) in parallel.

14.5.5 P.c.b. interconnections

Figure 14.5 gives a survey of all interconnections between the p.b.c.'s and to the CRT. Also the interconnections between the connectors on board level is given in this diagram.
An explanation of the connector indication is given below:



*: Input signal for the related p.c.b.
o: Output signal for the related p.c.b.
x: Interconnection between two or more sockets of the p.c.b.
Not used on the related p.c.b.

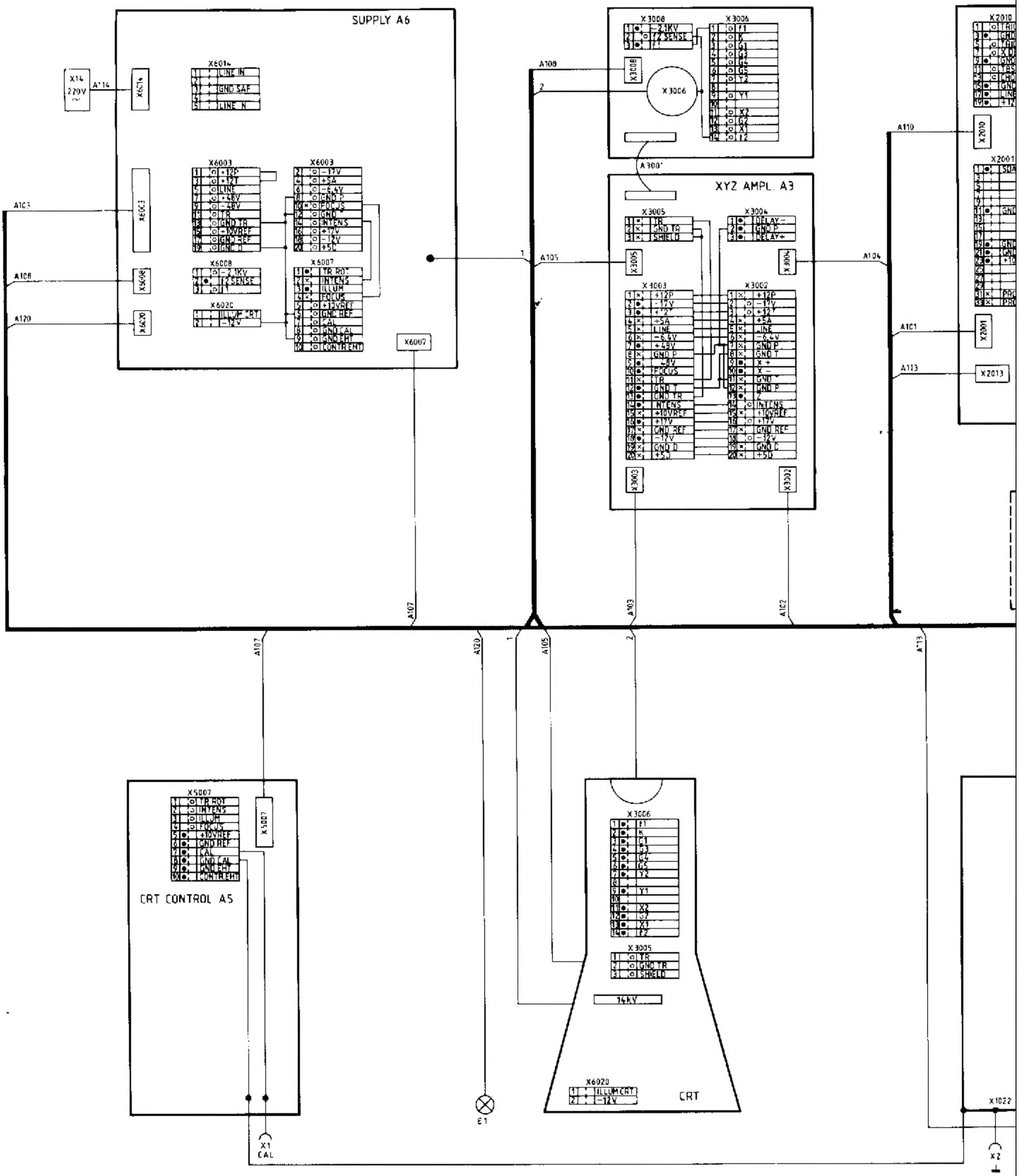
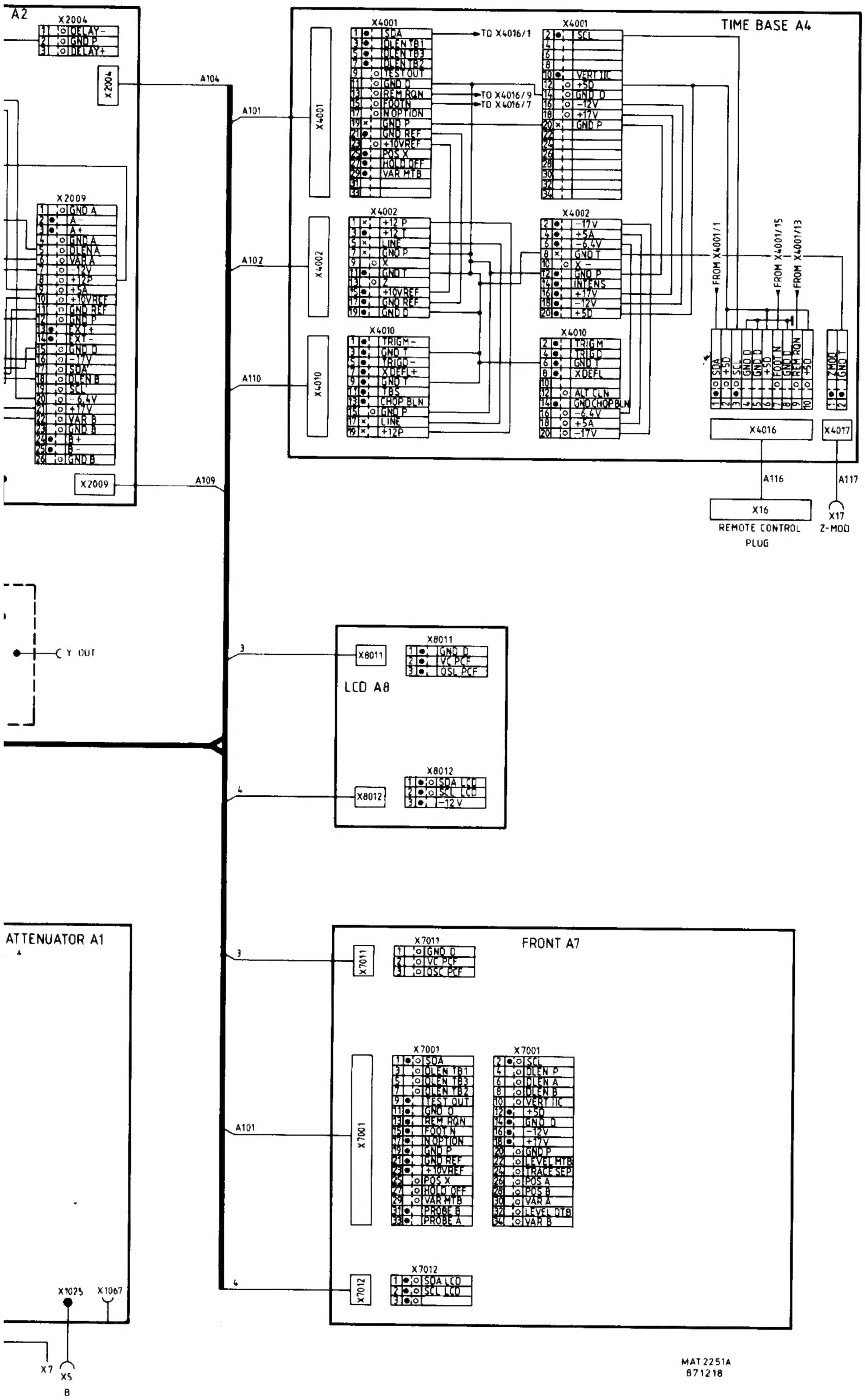


Figure 14.5 P.c.b. interconnections


TIME BASE A4
LCD A8
FRONT A7
ATTENUATOR A1
REMOTE CONTROL PLUG
Z-MOD
MAT 2251A
871218